A MANUAL

OF

MODERN SURGERY:

AN EXPOSITION OF THE ACCEPTED DOCTRINES AND APPROVED OPERATIVE PROCEDURES OF THE PRESENT TIME.

FOR THE USE OF

STUDENTS AND PRACTITIONERS.

BY

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WITH FIVE HUNDRED AND ONE ILLUSTRATIONS.

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THIS VOLUME

IS INSCRIBED TO MY FATHER,

CALEB C. ROBERTS,

TO WHOSE LIBERALITY AND CARE I OWE EDUCATION AND SUCCESS;

FROM WHOSE PRECEPT AND EXAMPLE I HOPE I HAVE

GAINED ACCURACY AND GOOD JUDGMENT.

PREFACE.

THIS treatise is the result of an effort to give the profession, in a condensed form, the accepted doctrines and approved procedures of Modern Surgery.

I have endeavored to write a practical work, giving the surgical principles and operative methods generally accepted and practised by the leading surgeons of the world at the present time. The opinions of the best authorities, the methods of the most practical surgeons, and the well-established facts of surgical science are discussed; but the consideration of theories, historical questions, traditional views and operations, and innovations of undecided value has been rigidly avoided.

The value of an author's discretionary power in such rejection or acceptance of material depends upon the carefulness of his analysis and the impartiality and soundness of his judgment. It has been my aim to bring these essentials to the work; hence, the statements of the volume represent my appreciation of the questions that have presented themselves.

In order to depict the present state of modern surgery I have consulted standard text-books and current surgical literature. The best and newest thought is usually found in the latest editions of monographs; therefore much use has been made of such works.

I am indebted to my friend Dr. Thomas S. K. Morton for writing the sections on Diseases and Injuries of the Joints, Diseases and Injuries of the Genito-urinary Organs, Dislocations, Excisions, Amputations, and the index. Without his efficient aid the publication of the volume would have been greatly delayed. Dr. Morton and Dr. C. L. Bower have given me much aid in reading the proof-sheets and in seeing the book through the press.

JOHN B. ROBERTS.

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PART I.

GENERAL SURGICAL PATHOLOGY, OR PRINCIPLES OF SURGERY.

CHAPTER I.

INFLAMMATION.

DEFINITION, CAUSES, VARIETIES, EXTENSION OF INFLAMMATION.

DEFINITION.—The process of inflammation, though of paramount importance to the surgeon and the subject of profound study and observation, is not easily definable. Its elementary features are unknown, because it is a vital process which the microscope cannot study except by its results. Hence, attempts to define inflammation are mere statements of its symptoms and effects. The word refers to the changes observed in animal structure following an injurious influence insufficient to cause immediate loss of vitality. This initial factor may originate from without, extrinsically, as a blow; or from within, intrinsically, as in inflammations due to deleterious elements circulating in the blood-current.

Inflammation, according to the present condition of pathological science, may be described as a peculiar molecular change in the walls of the small bloodvessels, dependent upon an extrinsic or an intrinsic irritation, which increases the adhesion of the blood to the vessel walls and allows permeation of the blood elements through them. Until the blood elements are allowed to escape by the abnormal permeability of the vascular coats, inflammation may be said not to exist.

Inflammation is not strictly a disease. It is Nature's reparative effort to overcome the perturbations caused by an injurious influence on the animal organism.

There are three terms, to which authors have given somewhat different applications, that, on account of their relationship to the process of inflammation, require explanation at this time. I give to them the definition which seems most logical, in the attempt to bring order out of the existing confusion. *Hyperæmia* is an unusual amount of blood in the vessels, due to any cause whatever. A hyperæmia due to physiological causation, as in glands during active secretion, in the skin in blushing, and in erectile structures, is called a *determination of blood*. Hyperæmia resulting from imperfect venous return, due to mechanical pressure on veins, gravity, or diminished cardiac power, is called *congestion*, which term should be employed only in this restricted sense. Hyperæmia produced by an increased amount of blood thrown into a part is often denominated "active congestion," but this tends to produce confusion. For practical

purposes this form of hyperæmia is the first step toward inflammation, and, though often no sensible effusion occurs, it might, with considerable propriety, be styled *inflammatory hyperæmia.*

Hyperæmia and inflammation have a close relationship, since hyperæmia whether physiological, mechanical, or active, if continued, leads to effusion and exudation, and inflammation at once exists. When inflammation subsides, hyperæmia is left as the last step toward restoration of the part to health.

To indicate inflammation of a structure the termination "itis" is added to the name indicating the structure affected, as synovitis, pleuritis.

CAUSES.—The causes of inflammation are: the exciting or determining, which give rise to the actual outbreak of inflammation, and the predisposing, which have previously created a tendency that requires merely an exciting cause to initiate the inflammatory process. Exciting causes may be *local,* as in injuries, and *constitutional,* as in syphilis. Predisposing causes, in like manner, may be *local,* as in the weakness of an organ resulting from previous inflammations, and *constitutional,* as in inherited or acquired impairment of bodily vigor. A given cause may be at one time an exciting, at another a predisposing, cause. For example, hyperæmia due to increased functional activity of an organ may be the exciting cause of inflammation; again, the same hyperæmia of the same organ may be the predisposing cause to which an irritation, acting as an exciting cause, must be added to induce the outbreak of inflammation.

Inflammation due to external injury is called *traumatic,* that without definite assignable cause *idiopathic.* The latter term must not be understood as implying that inflammation can arise without a cause. The cause is always present, but may elude our search. Inflammation cannot spread unless its cause has extended its area of influence, nor can it persist without a similar persistence of its causation.

In considering the causes of inflammation it must be remembered that there are two factors in its etiology—the cause which exerts an exciting influence, and the tissue upon which such influence is exerted. In some cases the exciting cause acts without any predisposition of the tissue being present, while, at other times, the same exciting cause cannot produce inflammation unless the normal resisting power of the tissue is lowered. This impaired resistance of the tissue may result from either an acquired or an inherited predisposition. It is seen, therefore, that the predisposing cause of inflammation may be anything which has a tendency to lower the health of the body, or the health of any part of the body. Among causes which may induce inflammation there are some which are perfectly obvious and easily detected. These produce what are often called simple traumatic inflammations. Under this head may be included mechanical and chemical injuries; injuries due to the application of heat or cold; those due to electricity, which causes electrolysis of the fluids, or to prolonged anæmia, or bloodlessness, of the part. Excessive functional activity and nervous influences are said to produce inflammation. Such inflammations do not tend to spread beyond the site originally subjected to injurious influences, nor to increase in severity after the application of the exciting cause has ceased. In fact, the height of the inflammation is reached soon after the receipt of the injury, and the inflammation rapidly subsides.

The irritation and consequent inflammation produced by a chemical agent does not, however, always show itself at the point at which the chemical agent gains admission to the body. Examples of this are seen

in instances of inflammation of the internal organs, such as the kidneys and liver, produced by the absorption of drugs through the skin or stomach. Alcohol, for instance, produces chemical inflammation of the liver. Certain drugs, on the other hand, act injuriously on the kidneys, by which organ they are eliminated from the blood. These are instances of inflammation due to chemical causes, but widely different, of course, from the inflammation of the skin produced by powerful caustics, where the inflammation is produced at the point of application of the agent.

Rheumatic and gouty inflammations are perhaps due to a similar action of chemical agents in the blood. The inflammations due to what is ordinarily called exposure to cold or wet are probably associated with an irritation of the vessels, due to driving the blood from the surface of the body to the internal organs.

Many inflammations whose causation was formerly obscure, and which were, therefore, called idiopathic, are now believed to be due to the presence of vegetable organisms. These fungi, which are variously called bacteria, microbes, and microörganisms, multiply in the fluids of the human body, and therefore furnish continuously acting causes. Inflammations resulting from these fungi, or microscopic plants, may be due to the mechanical or chemical action exerted by them.

There is a very great variation in the severity or type of inflammation due to these organisms; some of them are very virulent, causing at once gangrene, others cause a suppurative inflammation, and still others a chronic inflammation. The variety of inflammation may be fibrinous, suppurative, or productive. One of the most important inflammations produced by these fungi is that form which is called tuberculous. From what has been said, it is easily perceived that these organisms have individual characteristics. That form which produces a certain disease cannot produce any other disease, but such other disease is caused only by another form of organism having a different life history.

Again, there are many organisms which, by entering the fluids of the body, do not, so far as known, produce any form of inflammation or disease. These are called non-pathogenic organisms in contra-distinction to those above referred to, which are called pathogenic organisms.

In studying the microbic, or mycotic, origin of inflammation it must be remembered that the inflammation is not due to the mere presence of the microbes within the body, because, under ordinary circumstances, the normal resistance of the tissues to pathogenic processes prevents the occurrence of inflammation. In other words, bacteria moving freely in the blood-current may not inflame the tissues. Certain contingencies are requisite before their deleterious influence can be exerted. It is necessary that the organisms shall be arrested so as to be able to multiply and produce irritation; because, it requires a large number of these organisms in the tissue to produce a pathogenic change. Such arrest of bacteria may be caused by the processes of embolism or thrombosis, or by injury to a bloodvessel by which an extravasation of blood takes place into the connective tissue surrounding the capillary vessels; or they may be filtered out of the lymph-current by the lymph-glands. These processes which allow the microörganisms to come to rest and settle may be the needed factor which shall cause the advent of inflammation.

It may occur that, notwithstanding the arrest of bacteria, no inflammation occurs because there is no predisposition in the tissue at the point of arrest, or, in the general system of the patient, to suffer from microbic invasion.

This makes clear to us what is meant in the preceding paragraph by "predisposing causes of inflammation." Any circumstance which results in a depression of the vital powers, such, for example, as the continued abuse of alcohol, or prolonged anxiety and exhaustion, may induce a general or constitutional predisposition to inflammation. Bruises which cause extravasation of blood may act as a local predisposing cause; as, indeed, may any variety of wound. Wounds which are open to the air, by giving entrance to microörganisms upon the surface of the body and in the air, are much more prone to inflammation than subcutaneous wounds, since the latter exclude the bacteria which are external to the patient's body.

Some bacteria will cause inflammation only when they gain access to a certain kind of soil which is favorable for growth and development. Portions of the body, for instance, may be too cold for their development, in which event inflammation will not occur or will be arrested. If, however, these same organisms happen to become located in some part of the body which is warmer, they multiply and may at once excite inflammation. This illustrates what has been said before, that each organism has its peculiarity which must be accommodated in order to allow its development and pathogenic action. These microscopic plants are just as particular as to the kind of soil in which they grow, and as to the circumstances surrounding their growth, as are the trees with which we come in contact in the larger world.

Certain conditions of the blood, such as diabetes and Bright's disease, are particularly favorable for the development of certain forms of bacterial life and consequent inflammations.

The occurrence of inflammation depends upon other conditions than those already mentioned. The species of organism with which wounds and tissues are affected is a factor of imporance. Some organisms are much more virulent than others.

Again, the number of organisms which gain access to the tissues is a matter of importance. It can easily be understood that if but a small number infect the animal or human being, they can be destroyed or rendered inert by the normal resistance of the tissue. It is known that the leucocytes have a tendency to surround germs and to enclose them so as to prevent their acting upon the tissues. At other times the leucocytes or white blood-cells appear to eat up the bacteria, and hence are called phagocytes. If, however, the dose of pathogenic organisms is very large, or relatively large compared with the resistant power of the tissues and the leucocytes, inflammation will be induced.

It is a curious fact that the growth of several organisms together may induce inflammatory results, which no one of them alone is capable of effecting. This is seen in the harmful effects resulting from the association of putrefactive organisms and pus-causing organisms. In this instance it is probable that the putrefactive bacteria destroying the granulation tissue which may be present, allow the pyogenic fungi to gain access to the general circulation.

It is believed, also, that some organisms act antagonistically to other species of fungi. A patient inoculated with erysipelas becomes immune to infection with the anthrax bacillus.

The poison from microörganisms may be attenuated by certain laboratory methods of handling the fungi. If they are cultivated outside of the animal body, and not passed through some animal for a long period of time, they soon diminish in virulence. There are other methods of

cultivating these organisms, which in a similar way weaken or attenuate the poison. It is stated that the poisonous qualities may also be increased by similar manipulation in the bacteriological laboratory.

Microörganisms which are Associated with Disease.

The pathogenic vegetable parasites or fungi are of three kinds—bacteria, yeasts, and moulds. The first are the organisms to whose action most of the infective diseases are attributed. The disease which we call thrush, and which is characterized by grayish patches forming upon the mucous membrane of the mouth and adjacent parts, is due to a parasite which is one of the yeasts. A number of skin diseases are caused by the growth of pathogenic moulds. Favus, tinea tonsurans, tinea sycosis, and pityriasis are instances of parasitic skin diseases due to moulds. Actinomycosis is thought to be due to a fungus belonging to this class. It will be seen, therefore, that, for the surgeon, yeasts and moulds have little interest, while the first class, or bacteria, are of supreme importance.

It should be remembered by the student that the word bacteria is used very loosely by many to refer to all the kinds of parasitic fungi. It is better, however, to restrict it, as I have done, to a single class, to which is given the name schizomycetes. Bacteria are characterized by their method of multiplication, which is either by division, or by the formation of spores.

Yeasts, however, multiply by the budding process; while the moulds have a more complicated method of multiplication or reproduction, and are characterized by numerous threads which interlace and form the mycelium.

It is sufficient for our purpose to describe the different forms of cells which characterize the bacteria. If the cells are spherical or egg-shaped, the fungus is called a coccus; if the cells are straight rods, the fungus is called a bacillus; if the rods are curved, the name vibrio is used; when the plant assumes a more twisted form, it is called spirilla. These four terms, then, are used to give an idea of the shape of the plant, a single cell of which constitutes an individual. These cells may be grouped together in various ways. If the round or oval cells show a tendency to grow together in groups somewhat like bunches of grapes, the fungus is called a staphylococcus, or grape-coccus; if the same shaped cells always grow in straight chains, like beads upon a string, the plant is called a streptococcus, or chain-coccus; if there is a tendency for two round or oval cells to keep close together, but separate from other cells, the fungus is called a diplococcus.

These remarks make clear the terms used to describe the fungi found in surgical diseases. The streptococcus pyogenes is, in accordance with its name, a pus-causing chain-coccus; whereas the staphylococcus pyogenes is a pus-causing grape-coccus. There may be several kinds of staphylococcus or streptococcus, each of which has a distinctive adjective added to its name. Thus we have the white pus-causing grape-coccus and one of a golden color which has a similar pathogenic action.

In multiplying, as has been said, schizomycetes, or fission fungi, to which have been given the name bacteria, divide so as to form two or more individual cells. Some of them, however, multiply by the formation of spores, round or oval bodies, which grow within or from the cells, and subsequently become separate individuals. Some of these

microörganisms have the power of motion and are called, therefore, motile forms. The various forms differ from each other in the character of food which they require; though carbon, hydrogen, nitrogen, phosphorus, sulphur, magnesium, and potassium are needed, probably, by all. The presence of water is necessary for the development of fungi; therefore, thorough drying prevents multiplication of fungi, and, in some cases, kills them. Some require oxygen, which others can do without. The temperature to which they are exposed has also an important bearing on the life and development of nearly all forms. They are killed by boiling, or by a degree of heat very little above the boiling-point, provided that moist heat is used. Dry heat does not destroy them until it reaches a point considerably above the boiling-point. The bacillus of malignant pustule is of all pathogenic microörganisms the most difficult to destroy by heat. Spores will resist a higher degree of heat and more changes of condition without loss of vitality than will fully developed fungi.

Bacteria are found in the air, in the water, in the earth, and upon the external surface of the human body. These organisms in large numbers, both pathogenic and non-pathogenic, are found under the nails and in the various folds of the skin, such as the axilla. They are also numerous upon the mucous membranes which come in contact with the air, such as the bronchial and intestinal mucous membranes and those of the mouth and œsophagus. In many instances they do no harm, even if pathogenic; because of the resistance of the tissues to their action, which is great when the vitality of the tissues is unimpaired, or because of the comparatively small number which gain access to the tissues. Under favorable circumstances, however, multiplication is very rapid, and one individual may become many millions in twenty-four hours.

It has previously been stated that the mere presence of pathogenic organisms in the blood-current is not sufficient to give rise to disease. This, according to present pathological views, can only occur when the circumstances are favorable to their development within the body, and the resisting power of the tissue to their injurious action is imperfect.

The antagonism of the tissues to microbic invasion tends to prevent disease, unless the number or dose of infecting germs is too large to be successfully repelled. The leucocytes may form a wall or barrier around the bacteria, and, thus hemming them in, prevent their dissemination through the body; or they may be taken into the interior of the leucocytes and their vitality be destroyed.

Varieties.—All forms of inflammation are either acute or chronic. The acute is rapid in course or severe in symptoms, the chronic slow in progress or less severe in symptoms. It will thus be seen that the terms acute and chronic (perhaps improperly) each contain two ideas—one referring to time, the other to severity. The word subacute is used to express an intermediate severity between acute and chronic, but has no reference to time. Hence inflammation, as to time, is termed either acute or chronic; as to severity, it is expressed as acute, subacute, or chronic.

Although inflammation is essentially the same in whatever tissue it may occur, the character of the exudate varies in accordance with the resistance of the tissue, the intensity of the injurious causative influence, and the time of action of that influence. These variations in the exudate may often be found in the same inflammation by examining different areas of inflamed structure.

Serous Inflammation.—In serous inflammation the exudate is characterized by a small amount of albumin and few leucocytes, being,

indeed, very slightly different from the normal transudate of healthy tissues. This fluid does not coagulate. Instances of serous inflammation are seen in pleuritis with effusion, arthritis, hydrocele, and in inflammatory œdema of connective tissue. This form of exudate may be expected after slight or momentary injuries, in the early stages of more severe inflammations, and in cases where the blood is impoverished.

Fibrinous Inflammation.—Fibrinous inflammation gives rise to an exudate containing larger quantities of albumin and more leucocytes, and hence more coagulable. It forms, upon free surfaces and in the substances of organs, that which is clinically denominated "lymph." Lymph, then, is an inflammatory product consisting of fibrin and entangled leucocytes. It is sometimes called plastic lymph, to show that it is entirely different from the fluid called lymph which circulates in the lymphatic vessels.

The best examples of this form of inflammation are seen in the serous membranes, such as the peritoneum and pleura, and in the long continued or chronic inflammations of slight intensity in connective tissue.

At times we find a grade of inflammation intermediate between these forms, which may be termed sero-fibrinous inflammation.

These varieties of the inflammatory process may end by absorption of the exudate, which is accomplished by the leucocytes returning into the circulation by first entering the lymphatic vessels, and by the fibrin and some of the leucocytes undergoing fatty degeneration previous to such absorption by the lymphatic system.

Suppurative Inflammation.—In this very common form of inflammation the exudate contains the same elements as in the fibrinous, but does not coagulate. No lymph, therefore, is deposited, or, if any lymph has been deposited by the previous form of inflammation, it is destroyed by the accession of the suppurative stage. It is thus seen that the so-called varieties of inflammation are rather stages, or degrees, of the process. Suppurative inflammation is the result of a more irritative or longer continued cause than the serous or fibrinous forms.

Acute suppuration is another term signifying the same process. If the suppuration is circumscribed in an abnormal cavity, the resulting condition is called abscess ; if diffused in the tissues, purulent infiltration. Pus contained in a normal cavity, such as the pleural sac or knee-joint, is called a purulent effusion. If suppuration occurs upon a free surface of mucous membrane the condition is called purulent catarrh, provided the epithelium of the mucous surfaces is not destroyed ; while it is called ulceration if the epithelium and subjacent tissue are destroyed. Suppuration attacking a cutaneous surface also gives rise to what is called ulceration.

Productive Inflammation.—When the exudate of a serous or fibrinous inflammation becomes converted into new connective tissue, the inflammation is termed productive, because of the formation of this new structure. This process is accomplished by the fibrin disappearing and numerous leucocytes coming into the lymph, after which vascular loops from the capillary vessels of the inflamed structures penetrate the lymph and become surrounded by young cells. This new tissue, consisting of capillary loops and young cells, which have developed within the substance of the lymph, is called granulation tissue. Granulation tissue may be converted into connective tissue, often called scar tissue ; it may degenerate into typical tubercles ; it may become material looking like pus, but which is not true pus ; or finally, it may actually break down

into pus, the inflammation assuming the character of suppurative inflammation, which it then is.

The second transformation of granulation tissue gives rise to what is variously called "chronic" or "cold" abscess and chronic suppuration in bone.

Modes of Extension.—Inflammation cannot spread unless its cause extends before it; hence, inflammations due to mechanical and chemical irritants do not spread beyond the point at which the irritation was first exerted. All those inflammations which tend to spread from the original site are probably due to microbic causes. It may be taken for granted, in accordance with the present state of pathological knowledge, that the spread of inflammation is due to vegetable parasites. Such inflammations spread in three ways—by continuity of tissue, by the lymph-current, and by the blood-current.

When inflammation spreads by continuity of tissue, the bacteria which have settled there are spread into the surrounding tissues by being carried thither by leucocytes and by the lymph-channels. This mode of extension of an inflammatory process is comparatively limited in its action.

When mycotic inflammation spreads by the lymphatic vascular system, the bacteria are carried along by the current in the lymphatic vessels until they reach the first gland, where they are filtered out by the ramifications which the current makes in passing through the interstices of the gland. After being arrested thus they multiply and act as an exciting cause of inflammation, producing in the gland a secondary inflammation which is located at a considerable distance from the primary disease. This is quite different from the method of extension just described, where the fungi travel a short distance only in the lymph-current, or are carried short distances by the white blood-cells, choosing, as they do, the paths of least resistance. The blood-current may carry bacteria to all parts of the body, but they are innocuous, as a rule, until they are arrested by extravasation, by clotting of the blood, or embolic plugging of the vessels. Under these circumstances, secondary or metastatic inflammation occurs. Pyæmia is a good example of such metastatic inflammation. The inflammation of mumps being carried to the breast and testicle is a similar example of metastatic inflammation.

Pathology, Symptoms, and Terminations of Inflammation.

Pathology—The study of the pathological or essential nature of inflammation must be divided into a consideration of the rôles played by (1) the nerves, (2) the small bloodvessels, (3) the blood, and (4) the tissues. The changes occurring in each of these, though in the main synchronous, must be investigated separately.

1. *Nerves.*—The agency of nerves is really unknown. The vaso-motor nerves may have a causative influence in the dilatation of the vessels, due to a reflex action following irritation of the part affected; but of this nothing definite can be asserted. Recent researches show pretty conclusively that inflammatory phenomena depend on a direct injurious influence upon, and a vital alteration of, the walls of the bloodvessels, without the necessity of any direct nervous agency.

2. *Bloodvessels.*—As has been previously stated, the essential factor or lesion of inflammation is the change that occurs in the walls of the small bloodvessels, by which the friction between the wall and the blood-current

is increased and the wall is made more porous. In inflammation of non-vascular tissues, such as the cornea and cartilage, the same vascular alterations take place in the vessels which surround these structures, and upon which their nutrition depends. The vascular phenomenon of inflammation is dilatation of the arteries, capillaries, and veins; followed by acceleration, with subsequent abnormal retardation, of the blood-current. Mere acceleration of blood-flow not followed by abnormal retardation does not constitute inflammation, though it may lead to it. *The dilatation of the vessels and the abnormal retardation of the current must be permanent.* A preliminary contraction of the capillaries is at times seen, but it is not an essential factor.

While vascular dilatation and blood retardation are being established, the white corpuscles accumulate, especially in the venules, and the red corpuscles generally in the capillaries, until stagnation or stasis of the current occurs. This stage of absolute cessation of motion is preceded by one in which is seen a mere oscillation of the vessel contents synchronous with the cardiac pulsations. Synchronous with these vascular changes there occur permeation of the blood elements through the vessel walls and increased absorption by the lymphatic vessels.

3. *Blood.*—The white corpuscles (leucocytes) are relatively increased in inflammatory blood, and show a tendency to keep near the walls of the vessels. They are less heavy than the red corpuscles, and hence are thrown to the margin of the blood stream. Inflammatory blood when drawn shows more fibrin than non-inflammatory blood. This condition of hyperinosis and the buffy coat, formerly considered diagnostic of inflammation, have no diagnostic or therapeutic value. During inflammation white cells migrate through the walls of the venules, and red cells are pressed, as it were, through the walls of the capillaries into the surrounding tissues. This escape is supposed to occur through small openings (stomata) resulting from stretching of the walls of the dilated vessels. There is no emigration from the vessels in which absolute stagnation has taken place, nor from the arterioles. The escape of the white corpuscles usually greatly exceeds that of the red, and the vessels soon become surrounded and obscured by the crowd of extra-vascular leucocytes. In intense inflammations in very vascular tissues the red escape in greater numbers than the white corpuscles, and a resulting hemorrhagic spot is visible to the naked eye. The number of migrating cells is increased in the later stages of the inflammatory process. It is possible for the emigrated leucocytes—(1) to be transformed into tissue cells; (2) to re-enter the bloodvessels; (3) to enter the lymphatic vessels; (4) to become pus-cells.

There also occurs an escape or exudation of fluid derived from the blood liquor and similar to it, which, when associated with the escaped white and red blood corpuscles and the proliferating cells of the inflamed tissues, constitutes the inflammatory exudation, or, as it has been termed by some writers, inflammatory lymph or fibrin. The escaping fluid differs from the simple serous or dropsical effusion, that occurs in congestion or mechanical hyperæmia, in that it contains more white corpuscles, more albumin, and is more prone to spontaneous coagulation. It differs from blood liquor, or liquor sanguinis, in having less albumin and less coagulability. I prefer to call this inflammatory fluid an *exudation of lymph,* or simply an *exudate,* and the escape arising from venous distention a *transudation of serum,* or simply a *transudate.*

This exudate or inflammatory lymph is of paramount importance to

the surgeon, for, by its organization and transformation into tissue analogous to that at the seat of injury or disease, hemorrhage is prevented, wounds united, abscesses circumscribed and limited, plastic surgery made possible, and other reparative surgical processes accomplished. At times, however, it produces morbid conditions, strictures, and adhesions, alters structure by interstitial deposit, and is exceeding destructive to functional integrity.

It is well, it seems to me, to apply the term exudate, or lymph, to effusions occurring from inflammation, even when they closely resemble the serous transudate of mechanical venous obstruction. The milder forms of inflammation give rise to a fluid containing so little albumin and having so little tendency to coagulation that it is impossible to distinguish it from the fluid of a non-inflammatory dropsy. If, however, inflammation exist, let this be called lymph; if inflammation does not exist, call it a transudate or serum.

On mucous or serous surfaces the exudate is readily seen during the progress of inflammation; in some tissues it is exhibited as swelling; in the cornea and other non-vascular structures it is found surrounding the part, because it is the adjacent vessels which present the inflammatory alterations. *The blood phenomena of inflammation, then, are migration and exudation.*

4. *Tissues.*—The tissues are swollen and infiltrated with the escaping blood elements, and the proper cells of the tissue involved show disordered nutrition, such as coagulation-necrosis and fatty degeneration. The impairment of nutrition may result in the formation of inferior tissue, suppuration, or gangrene. The peptonizing action of microörganisms has to do with the inflammatory destruction of tissue, and thus aids the malign influence of the chemical and physical changes wrought by original injury and the deluging of the tissues with escaping blood-elements. Within the tissues there is proliferation or multiplication of the white blood-cells which have escaped from the vessels; but multiplication of the proper or native cells of the tissue does *not* take place, except when repair or regeneration of tissue is going on coincident with inflammation of only moderate intensity. This proliferation must not be considered as a part of the inflammatory process. During inflammation the tissue elements are obscured by the intermingled white corpuscles and filaments of fibrin; and the structures are changed in physical consistence, being sometimes softer than normal, at other times harder.

The tissue alteration of inflammation, then, may be described as *disturbance of nutrition associated with proliferation of white blood-cells.*

The phenomena of inflammation may finally be thus formulated:

1. Nerves: Unknown, or possibly vaso-motor influences.

2. Bloodvessels: Permanent dilatation of calibre associated with permeability of walls.

3. Blood: Permanent abnormal retardation of current associated with migration and exudation.

4. Tissues: Disturbances of nutrition associated with proliferation of white blood-cells. It was formerly held that the native or tissue cells also underwent proliferation.

SYMPTOMS.—The local symptoms of inflammation are those exhibited at the point at which the process is going on; the constitutional or general symptoms are manifested by the patient's organism as a whole and are observable in functional derangement of the various organs without any necessary relation to the situation of the inflammatory changes. The

general symptoms imply an existing inflammation, but do not indicate its locality.

The local symptoms are pain, discoloration, swelling, heat, and disordered function. It requires the co-existence of a number of these abnormal manifestations to constitute inflammation, and one or more may be prominent or entirely absent, according to the variety of the inflammation and the nature of the inflamed tissue.

Pain is a subjective symptom of inflammation, while the other manifestations are, for the most part, really objective physical signs. The pain of inflammation is due to pressure of the exudate on nerve-endings and possibly to chemical irritation exerted upon them; is persistent; is increased by motion and the dependent position; and must be distinguished from the paroxysmal pain of neuralgia and spasm. Its severity depends more upon the tissue affected than the degree of inflammation, and is often inverse to the amount of swelling possible, because the pressure of the distended vessels and exudate upon the nerve filaments is increased when the structures are too dense to allow swelling. Pain may be reflected by nervous distribution to a part remote from the seat of disease, as occurs in coxalgia; in such cases it is not strictly a local symptom. Throbbing pain, which is due to increased tension at each pulsation of the heart, is usually indicative of the advent of suppuration.

The discoloration usually varies from the shades of red, the usual hue, to those of purple and blue. It is essential that the alteration in color be permanent, for the transient hyperæmia of merely physiological causation also produces redness. In the cornea, arachnoid, and similar non-vascular structures the change is manifested by a whitish opacity and a loss of lustre, while the surrounding vascular tissues present the usual inflammatory redness. In iritis there is a loss of lustre and a brownish discoloration.

The blackness of gangrenous tissue and the whiteness of necrotic bone have been erroneously instanced as illustrations of inflammatory alteration of color, but, since inflammation ends at the moment death of tissue occurs, these are not strictly inflammatory discolorations. The cause of the red discoloration in inflammation is the abnormal amount of blood in the vessels, and, perhaps, at times, a real staining of the tissues by the coloring matter of the corpuscles. As resistance to flow of blood increases because of change in wall of vessels and pressure from exudate, the parts become bluish, or mottled and pale.

The temperature of an inflamed part is usually increased. It is frequently above 100° F. There is no production of heat at the inflammatory focus, but the increase is due to the increased rapidity of the arterial circulation. A local increase of heat in chronic inflammation may be imperceptible; hence, for example, we speak of "cold" abscesses.

Inflammatory swelling is due to the increased amount of blood in the vessels and to the migration and exudation which occur. If the exudate consists principally of fluid the part is said to be œdematous; and a depression made in the surface by pressure of the surgeon's finger is apt to remain for a few moments as a little pit. This "pitting" does not show if the tissues are tensely stretched. It is most typical in œdema from mechanical hyperæmia. Usually the exudate is cellular rather than fluid and the swollen tissues are too hard to pit. Swelling is always great in those parts, such as the scrotum, formed largely of loose connective tissue, because there is less resistance to the escape from the vessels of inflammatory products. In dense resisting structures and under

tense fasciæ much swelling is impossible; and hence, great pain is experienced during inflammation in such localities. The tissue-pressure thus induced may lead to gangrene by totally obstructing circulation, if not relieved by free incisions to allow escape of fluids and to relax distended structures. The occurrence of swelling is frequently beneficial by diminishing the intravascular pressure. If the exudate is small in quantity and the lymphatics carry it off, no swelling will exist. This occurs in slight grades of inflammation.

Disordered function is a symptom (sometimes subjective and sometimes objective) always present, and attracts attention when the other manifestations of inflammation are more or less in abeyance. The increased or impaired sensibility of the sense organs; the irritability of the hollow viscera; the modified secretions of the various glands; and the alteration of nutrition, shown by defective absorption, by atrophy and hypertrophy, are all well-known instances of functional disturbance arising from inflammation. The injury inflicted upon every tissue by the morbid process readily explains the functional disturbance.

The general or constitutional symptoms of inflammation are grouped together and called inflammatory or symptomatic fever, because the increase of the general bodily temperature is such a characteristic member of the group. The terms traumatic fever and surgical fever are sometimes employed as synonyms of inflammatory fever when the inflammation is due to an injury. Inflammatory fever varies with the intensity, extent, and locality of the process, and with toxic influences associated with it, and is practically absent in slight inflammations of unimportant localities and when microbic infection of the blood is prevented. It depends on the presence in the blood of products of the morbid tissue-change occurring at the seat of inflammation, or of poisonous principles manufactured at the seat of injury by microörganisms of a vegetable nature. The most important duty of the surgeon is to protect all accidental or operation wounds from infection by these vegetable parasites, which, under the general name bacteria, enter the blood-stream and are believed to be responsible for all grave degrees of inflammatory fever. Inflammatory fever, in other words, is usually a poisoned condition of the blood due to microörganisms. Inflammatory fever becomes prominent within twenty-four hours after the incipiency of the local symptoms. There are two types of constitutional disturbance in inflammation: the sthenic, representing excess of force; the asthenic, representing want of force. The irritative type, so-called, is not a special form, as all cases are necessarily either sthenic or asthenic. The respiratory, circulatory, digestive, nervous, secretory, and other general symptoms accompanying inflammation show modifications according to the type of the constitutional disturbance; hence, as the treatment must greatly vary in the two conditions, the necessity of an early recognition of the type is evident. The constitutional symptoms of inflammation, when asthenic, resemble those of typhoid fever; hence, they are often said to belong to the "typhoid condition."

The student must remember, however, that typhoid or enteric fever and the "typhoid condition," though presenting similar symptoms, are different entities.

The following table shows the differential diagnosis of *typical* cases of sthenic and asthenic inflammatory fever:

	Sthenic.	*Asthenic.*
Patient	Usually of vigorous constitution.	Previously of weak constitution, though may have been vigorous.
Pulse	Full, bounding, 90–120.	Compressible, weak, 120–160.
Respiration . .	Oppressed, hurried.	Shallow (?), hurried.
Digestive organs.	Constipation, loss of appetite, white furred tongue, thirst.	Bowels irregular, tendency to diarrhœa, loss of appetite, brown and dry tongue, sordes, thirst.
Skin	Dry and hot, temperature 100°–105°, chill at beginning.	Often clammy, temperature 99°–101°, chills and colliquative sweats.
Urine	Scanty, highly colored, uric acid abundant, chlorides diminished.	No marked difference from sthenic type.
Nervous system .	Restless, headache, active delirium.	Stupor, not much headache, muttering delirium.
Muscular system.	Pain in back and limbs.	Twitching of tendons.

Terminations.—There can be but two terminations of inflammation. First, gradual return of the tissues to health without destruction of their elements and functions; and second, death of these tissues, which may take place molecularly or in masses large enough to be readily seen. When inflammation terminates in the first manner the walls of the blood-vessels are restored to their normal condition, the deposits absorbed and the damaged tissues regenerated. *Resolution* is then said to have taken place. In the second instance, if death occur *molecularly*, that is, if small particles die, it is called *ulceration* if in soft tissues, and *caries* if in bone; while death *in mass* of soft parts is termed *gangrene*; of bone, *necrosis*. It should be observed that pathologists apply the term necrosis to all forms of tissue-death, whether in bone or soft structures, in mass or in small particles.

When the surface of an inflamed mucous membrane suffers death and is covered with a gray, yellowish or reddish membrane, which is tough and adheres to it, the inflammation is said to be of a diphtheritic character. Such gangrenous inflammations occur on the conjunctiva or any other mucous membrane, and may attack wounds. They are infective inflammations and take their name from the disease diphtheria, which often, but not always, gives rise to a pharyngeal inflammation of this character. Not all diphtheritic inflammations, however, are diphtheria. These membranes differ clinically from the layer of lymph which ordinarily forms on inflamed surfaces by the great difficulty with which they are detached.

The results or sequences of inflammation, such as newly organized tissue, adhesions, effusions, exudations, pus, sloughs, and sequestra must not be confounded with its terminations. It can only terminate either in a return to health of the tissues inflamed or in the death of the same. The parts in the vicinity may continue in a state of inflammation, but the death of tissue, by either ulceration or gangrene, effectually terminates the inflammatory process in that particular issue.

Resolution is the termination of inflammation which the surgeon ordinarily aims to secure, but in many instances it is impossible to obtain it, and suppuration, ulceration, or gangrene occurs. Hence, after considering the treatment to be pursued in the endeavor to obtain resolution, I shall discuss suppuration, ulceration, and gangrene.

Treatment.—The most important precept that can be taught in relation to the management of inflammation is this: Inflamed structures tend to recovery as soon as the cause of inflammation is removed. Hence, when the surgeon can remove the cause the rest of the treatment consists in merely waiting for the reparative efforts of nature, and in averting any secondary irritative action that may supervene. When the obscurity of

the cause precludes its removal, efforts must be made to avert the advance and the destructive effects of the inflammation, until the cause ceases to be operative.

The indications of treatment in all cases of inflammation, then, are to remove the cause and to establish resolution as promptly as possible.

Removal of the cause is to be effected on general rational principles: for example, a foreign body is to be extracted from the tissues; the patient himself is to be transported from unfavorable surroundings; or, if the cause lie in some vitiated state of the blood, remedies to remove that state are to be administered. Attempts to remove the cause are not justifiable, however, if they render the patient liable to conditions more dangerous to life than that for which he is being treated, for it must always be remembered that the surgeon is treating a condition rather than an entity.

Resolution, if possible, is to be induced by local and constitutional measures. The latter, of course, includes hygienic and dietetic as well as medicinal agencies. After injuries and operations the surgeon desires the presence of reparative inflammation to heal the wounds, and, therefore, little is required except attention to prevent the occurrence of inordinate inflammatory action. The prevention and arrest of microbic infection of wounds is the most important duty of the surgeon in this connection. The means by which these ends are to be accomplished will be discussed under Treatment of Wounds.

The local treatment of inflammation is properly discussed before the constitutional, because many cases of minor severity demand no constitutional treatment whatever. Inflammation is treated locally by (1) position and functional rest; (2) cold; (3) heat; (4) anodynes; (5) blood-letting; (6) diminishing arterial supply; (7) antiseptics and necrotics; (8) stimulants and astringents; (9) counter-irritation; (10) compression and friction.

Position and functional rest.—Rest from functional activity and that position which renders afflux of blood to the part most difficult are essentials in treating inflammation, especially when acute. Elevation and immobility of the parts are, therefore, usually to be enforced, supplemented in many cases by confinement to bed.

Cold.—The depressant and sedative action of cold is utilized as a preventive of inflammation, and, in the earliest stages of the process, to limit its severity. It should not be employed when suppuration or mortification is to be feared, nor, as a rule, in chronic inflammation. Cold and moisture may be applied by cold baths, rapidly evaporating lotions, or by irrigation in which a constant application of water, simple or medicated, is maintained by allowing it to drop on cloths laid over the inflamed part. Dry cold is obtained by using tubes or rubber bags filled with cold water or ice.

Heat.—Heat is practically always combined with moisture, because all warm applications soon become saturated with secretions from the skin. Hot dressings are properly used when there is pain and tension, a tendency to suppuration, and a probability of mortification. They aid in mortifying processes by causing separation of the sloughs, thus promoting the suppurative action beneath the dead tissue. Heat is usually indicated when cold is contra-indicated. It may be obtained by local baths of hot water or steam, fomentations, poultices, etc.

Any warm or hot application combined with moisture acts as a poultice if evaporation be prevented by rubber cloth, waxed paper, or other

impervious covering. The protracted use of heat is objectionable because it causes relaxation of tissue. When suppuration is inevitable deep incision is preferable to poultices, because it relieves pain promptly, prevents destruction of tissue, and hastens cure. It is probable that the value of moist heat is largely due to its increasing the migration of white blood cells, which thus, by their numbers, become more powerful in their antagonism to the microörganisms causing the inflammation.

Anodynes.—The narcotics, especially the preparations of opium and belladonna, are frequently beneficial by relieving the pain of inflammation. Extract of belladonna, softened with water and smeared over the surface, and opium combined with acetate of lead are favorite prescriptions.

Local bloodletting.—The direct abstraction of blood from engorged vessels and the opportunity of escape afforded deposits infiltrating the tissues are the means by which puncture, scarification, incision and wet cupping act as potent agencies in combating inflammation. At times it is not practicable to incise the vessels and tissues of the inflamed organ, and then wet cupping or leeching at an adjacent point is done to relieve the hyperæmic structures. As a rule the bloodletting should be applied at the focus of inflammation, and the bleeding encouraged by warm applications. The advantage of incision over poulticing has been mentioned previously.

Cutting off arterial supply.—This is done be applying pressure upon, or by ligating in its continuity, the main artery, and thus diminishing the supply of blood to the inflamed member. Ligation has seldom been resorted to, except experimentally; but intermittent digital pressure or partial compression by compresses is occasionally judiciously employed as a prophylactic measure after operations on the extremities.

Antiseptics and necrotics are adapted to the treatment of wounds, and are usually employed as prophylactics to prevent excessive inflammation liable to occur from pyogenic or putrefactive bacterial infection or from inoculation of animal poisons.

The use of carbolic acid, corrosive sublimate, beta-naphthol, and similar agents, will be described in discussing the antiseptic treatment of wounds. The most efficient necrotics to prevent absorption of the poison of hydrophobia, snake-bites, etc., are the actual cautery, strong nitric acid, and acid nitrate of mercury. Immediate excision is preferable when it can be adopted.

Stimulants and astringents.—These local remedies, of which nitrate of silver and acetate of lead are examples, occupy a high rank in the treatment of inflammation, especially of mucous membranes. The more chronic the inflammation the stronger must be the stimulant and astringent impression.

Counter-irritation is applied at a point more or less remote from the inflammatory focus, and varies in degree from mere redness of the skin to vesication, suppuration, and complete destruction of the skin as by the actual cautery. Except in the mildest form, as obtained by sinapisms, counter-irritation is seldom used in acute inflammation. It probably acts by abstracting blood from, and lessening the textural excitability of, the inflamed organ.

Compression and friction.—Compression, by means of muslin or elastic bandages or adhesive strips, and friction, or manipulation (massage), either with or without oils and liniments, are most efficient means of relieving muscular spasm and of producing absorption of deposits in chronic and the late stages of acute inflammation.

CONSTITUTIONAL TREATMENT.—The general or constitutional management of inflammation comprises: 1. Abstraction of blood by venesection. 2. Increase of secretion and elimination by cathartics, diaphoretics, diuretics, and emetics. 3. Diminution of vascular tension by cardiac depressants. 4. Increase of vascular tone by tonics and stimulants. 5. Decrease of nervous excitement by anodynes. 6. Reduction of temperature by antipyretics and the general application of cold. 7. Correction of morbid conditions of blood by alteratives and specifics. 8. Regulation of sanitary surroundings and diet.

These measures, however, as well as the local means, are not all to be employed in each instance of inflammation, for, while some are appropriate to the sthenic type, others are adapted to asthenic cases. Moreover, it is to be remembered that many medicinal agents have a combination of activities, being, at the same time, evacuants, anodynes, and cardiac depressants; hence, one or two remedies will often meet all the requirements.

Venesection.—In the early stages of acute sthenic inflammation, when the after-depression from loss of blood will be less detrimental than the threatened destruction of the integrity of a vital organ, general blood-letting is beneficial. Venesection acts mechanically by lessening the amount of blood in the system, and, therefore, relieves inflammatory engorgement, which *may* be the most disastrous factor of the inflammatory process demanding treatment. This is especially true of pulmonary and cerebral inflammations. Vascular engorgement, however, is the result, not the cause of inflammation, and removal of blood is not removal of inflammation. Venesection should never, as a rule, be employed when the pulse is feeble and frequent and the symptoms those of asthenia, nor when it is probable from the activity of the inflammatory attack, as in blood-poisoning, that depression will shortly follow.

Cathartics, diaphoretics, diuretics, and emetics, are internal remedies of value; because they increase glandular secretion, which is arrested in inflammatory fever, act as derivatives by attracting blood to other organs, deplete by drawing away the watery constituents of the blood, expel irritating substances from the system, and have a refrigerant or cooling effect.

Depressants.—Aconite, veratrum viride, and antimony are the cardiac sedatives most frequently employed to reduce the high vascular tension, exhibited by the full, bounding, frequent pulse of acute inflammation occurring in robust, plethoric persons. They are selected when the depressing influence of venesection is considered unwarrantable.

Tonics and stimulants.—Asthenic inflammations, on the other hand, require from the first, quinia, iron, digitalis, alcohol, and highly nutritious food, to increase cardiac power and sustain life under the depressing effects of the inflammatory process. The same remedies are usually needed after the subsidence of active sthenic symptoms, which leave the patient emaciated and exhausted by the severity of the structural changes that have taken place.

Anodynes.—Pain, restlessness, and general nervous excitability call for the administration of opiates, chloral, the bromides, sulfonal, hyoscin, and kindred drugs, to give physiological and functional repose. The beneficial effect on inflammatory fever of a few hours' profound sleep is familiar.

Cold.—Sponging the surface of the body, cold packs, and cold baths are certainly effectual in diminishing bodily temperature, and are

employed advantageously in inflammatory affections. Antipyrine, antifebrin, and similar drugs with a known ability to lower the general temperature are often valuable remedies.

Alteratives and specifics.—Certain inflammatory lesions are best combated by specific remedies, which have some alterant or eliminating blood action and which should be given as soon as the diagnosis is established. As examples may be mentioned mercury and the iodides in syphilitic inflammations, quinia in malarial,[1] and colchicum in gouty lesions. Mercury, because of its supposed antiplastic action, was long given in all inflammations to lessen the deposition of lymph, but this belief has deservedly, I think, lost ground. The removal of inflammatory products in chronic conditions is certainly effected by the so-called sorbefacients, among which the preparations of mercury, iodine, and ammonium chloride stand preëminent.

Sanitary and dietetic measures.—Cleanliness of person and of surgical dressings, freedom from microbic and deleterious atmospheric influences; regulation of the temperature of the room; proper ventilation; freedom from noise and anxiety; good nursing and judicious diet are more important than any one requirement heretofore mentioned under the constitutional treatment of inflammmation. Acute sthenic cases may require some restriction of diet, but not the starvation treatment of past generations of surgeons. Asthenic inflammation invariably requires concentrated, easily digestible food at frequent intervals.

In conclusion, a recapitulation of the differential therapeutic indications of sthenic and asthenic and of acute and chronic inflammations may be instructive.

Sthenic cases present symptoms of overaction, and require depleting, depressant, and non-stimulant remedies, with restricted diet.

Asthenic cases present symptoms of depression, and require corroborant, tonic, and stimulant remedies, with abundance of nutritious food.

Acute inflammations, being either sthenic or asthenic, require treatment according to their type, with depleting and soothing applications locally.

Chronic inflammations, being usually more or less asthenic in type and characterized by much inflammatory deposit, require tonic and alterative treatment, with stimulating applications locally.

CHAPTER II.

SUPPURATION.

Mention of suppurative inflammation has been made in a previous section, but, so important is the relation of the suppurative process to operative surgery and surgical pathology, that it is necessary to consider a little more fully the clinical history of this pathological condition.

Suppuration, or the formation of pus, is due to causes which are sufficiently intense and sufficiently prolonged in their action to give rise to suppurative inflammation, and which have the peculiarity of preventing the formation of fibrin in the inflammatory exudate. According to present pathological views, it is believed that the yellow liquid called pus, laudable pus according to the older writers, never occurs except when vegetable fungi are present. In some other cases there is a liquid found which is often called pus, but which is not true pus. This kind of fluid is found in so-called chronic abscesses, in bone abscesses, and under other circumstances. It is preferable to call it a puriform liquid, and restrict the term pus to the creamy discharge that escapes from acute abscesses and ulcerated surfaces.

Let it be understood, then, that for the clinical purposes of the surgeon pus never occurs except in association with microörganisms, and, therefore, does not occur in inflammation of a simple traumatic kind, unless the seat of the inflammation becomes infected with fungi. There are about twelve vegetable parasites which are known to cause the formation of pus; those most frequently found are the staphylococcus pyogenes aureus, the staphylococcus pyogenes albus, and the streptococcus pyogenes. The first two are grape coccusses, while the streptococcus is a chain-coccus; the two former usually produce circumscribed suppuration and abscess, while the streptococcus is usually the cause of spreading and diffuse suppuration.

The importance of this connection between organisms and suppuration is very clear, because it indicates at once that great care must be taken to prevent infection, in simple traumatic inflammations, with germs from the hands of the surgeon, his instruments, or dressings.

Pus is a yellow or greenish-white, alkaline fluid, presenting characteristics varying with the peculiarities of the inflammation producing it. It consists of a liquid in which float white corpuscles. The pus liquor is composed of water, albumin, fats, and salts, and is derived from the blood, with the liquid portion of which it seems to be almost identical. It contains, however, the pus-forming microörganisms and their chemical products. The corpuscles are, in fact, the migrated leucocytes referred to in the section on the pathology of inflammation, which have now lost their vitality. Some of them are still capable of changing their shape and migrating, and are considered to be the white blood-cells which have just escaped from the vessels. As usually seen under the microscope the corpuscles are dead, and have lost the amœboid movements of the living cells.

Pus has a tendency to cause liquefaction and disintegration of the tissues with which it comes in contact. It may itself occasionally be absorbed after fatty metamorphosis, or be changed into a caseous mass; as a rule, however, if not evacuated by operation it is discharged through an opening produced by its disintegrating action on the overlying tissues. It may be secreted from a free, unbroken surface, as in inflammation of mucous membrane, and constitutes most of the discharge in all cases of ulceration.

VARIETIES.—When a granulating surface in a healthy person is progressing favorably toward cicatrization the pus secreted is of a creamy consistence, and has a specific gravity of about 1030, yellow color, and little or no odor. These features, therefore, pertain to what was formerly called healthy, or laudable pus. The so-called unhealthy pus is frequently, though not always, thin, of low specific gravity, of a dirty yellow or reddish color, and has often an offensive smell, and a tendency to irritate the skin. It is termed ichorous, or sanious pus. Other adjectives are used to describe various conditions and appearances of pus; thus curdy, gummy, scrofulous, sanguinolent, contagious pus, and muco-pus are terms often heard, but most of them are indefinite and unscientific. At the present time the occurrence of pus is believed to be due to infection of the wound by microörganisms; hence no pus can be called healthy. Wounds, however severe, will, if kept free from organisms, heal without pus.

TESTS.—Pus mixed with other fluids can be detected by the addition of solution of potassa, with which it forms a gelatinous mass. This and other tests, however, are inferior to microscopic examination, which discloses the characteristic spheroidal semi-transparent corpuscles, from $\frac{1}{3500}$th to $\frac{1}{2500}$th of an inch in diameter, containing granules and nuclei. The nuclei are made more distinct by the addition of dilute acetic acid. Some of these corpuscles are identical in appearance with white blood-cells, and are the white cells which have just escaped from the vessels.

FIG. 1.

Pus corpuscles as seen after death: *a*, before, *b*, after the addition of acetic acid. × 400. (GREEN.)

Microscopic examination with suitable illumination and sufficiently high oil-immersion lenses will bring to light the microörganisms to whose presence the suppurative action is due.

ABSCESS.

DEFINITION.—An abscess is often described as a collection of pus circumscribed by a wall of lymph, or as an abnormal cavity containing pus; while suppuration occurring within the meshes of the connective tissue without such limiting wall is called a *purulent infiltration*, and a secretion of pus from a mucous, serous, or granulating surface, a *purulent effusion*.

These distinctions are frequently ignored, however, for a "diffused" abscess is an impossibility if abscess means a *circumscribed* cavity filled with pus; and certainly the expression, "abscess of the knee-joint," is more common than "purulent effusion in the knee-joint." It would be less confusing to define an abscess simply as a cavity containing pus,

without any restrictions as to a limiting wall or to the nature of its surroundings. There is certainly no etymological objection to this use, which is certainly in accordance with the ordinary signification of the word. The symptoms, diagnosis, and local treatment of pus in the normal sacs and cavities, as the pleural cavity and knee-joint, and in newly-formed spaces in the connective tissue are the same; and they are practically, in both cases, abscesses.

VARIETIES. *Acute abscess.*—When pyogenic organisms are arrested in the tissues they multiply and cause coagulation-necrosis in the cells. To prevent the injurious effects of these organisms a large number of leucocytes appear in the region affected, and, by their endeavor to prevent encroachment of the microörganisms upon other tissues, form a wall around the group of germs.

The antagonism between the organisms and the leucocytes is kept up until the wall of granulation tissue created by the action of the white blood-cells is too dense for the microörganisms to penetrate. It is thus that the suppurating focus is circumscribed; within this wall the tissue cells break down, and under the peptonizing influence of the microorganisms the formation of fibrin in the exudate is prevented. The cavity of the abscess, therefore, contains dead leucocytes, microörganisms, and their chemical products, and destroyed tissue cells, in addition to inflammatory exudate. These constituents make up the creamy liquid which is called pus.

The tendency of the pus contained in this cavity is to soften the surrounding tissue and to spread in the direction of least resistance until it is discharged through an opening upon a free surface. This is called the pointing or spontaneous opening of an abscess. Such a spontaneous opening relieves the tension, which has been one of the causes of the continuance of the inflammation, and permits the pus and microörganisms to be evacuated. The collapse of the walls of the abscess and the adhesion of the opposite surfaces readily complete the cure, if the admission of putrefactive bacteria is prevented.

In the event of putrefaction taking place, suppuration continues for a comparatively long time, according to the situation and the character of the abscess. Healing of the abscess may be hastened by the surgeon opening the cavity and evacuating its contents long before the pus reaches the surface; but, in this event, it is equally important that the operation should be done antiseptically, since the admission of putrefactive and pyogenic germs would keep up the inflammation and the suppuration, as it would after spontaneous evacuation.

Very rarely the pus of an acute abscess may become encapsulated and undergo caseation or calcification; the mass in a sort of sac may then remain in the tissue as an innocuous tenant for many years, though it forms a spot of least resistance at which inflammation may readily be set up at any future time.

Diffused suppuration frequently occurs and causes what is often called *diffused abscess.* The process is of similar pathological nature to that just described, but the pus is not enclosed in a distinctly limited cavity. The condition is due to a more intense inflammation, and is usually believed to be due to the presence of the pyogenic streptococcus, which has a more intense peptonizing influence on the cells than the mycotic causes of such suppurations as are limited by a distinct barrier of cells. Sloughs and shreds of gangrenous tissue are often found commingled with the pus of diffused suppuration.

The acute or phlegmonous abscess necessarily corresponds in symptoms with acute inflammation, of which it is a result. The advent of suppuration in the progress of acute inflammation is often marked by rigors and great constitutional disturbance; after which the throbbing local pain, the shining red skin, and the acuminated appearance indicate that an abscess is being formed. The pus usually produces softening of structure, and tends to escape toward a free surface. The consequent elevation of the overlying tissues is distinctive of an abscess about to point, and, as the skin becomes thin over the advancing pus, the characteristic yellow color becomes apparent, after which a small slough is separated, leaving an orifice through which the pus is discharged. The walls of the abscess then collapse, and the cavity is filled up like an ulcer by the granulating process; in fact, an abscess within the tissues has been called a "closed ulcer." Deep abscesses may produce very little change upon the surface, except a localized œdema.

Metastatic abscesses are essential elements of pyæmia, and will receive consideration under that heading.

The so-called *chronic* or *cold abscess*, which is probably usually a lesion of tubercular inflammation and is, therefore, slow in progress, does not exhibit very active local symptoms. It is apt to occur in connection with bones and lymphatic glands and in persons of the so-called scrofulous habit, but may be found in any region and in any patient. There is no heat of skin, little or no cutaneous redness, no pain, and generally no tendency to pointing. The skin becomes thin over the puriform collection and an orifice by which the contents escape may form after a long time; but, instead of the pointed elevation of an acute abscess, there is seen a general rounded protrusion of thin and purplish integument. The puriform liquid is confined by a thick wall, forming a tough sac lined with velvety elevations, and is usually thin in consistence, containing cheesy masses, ill-formed corpuscles, and cholesterin crystals. It is not pus in the strict sense, and should be discriminated from that which is found in acute abscesses. Chronic or tubercular abscesses often become very large, because they do not tend to spontaneous evacuation. If we do not consider the fluid in these so-called chronic abscesses to be pus, and it certainly differs from pus, the term abscess is inappropriate. The term, however, is still retained because of its convenience.

Diagnosis.—Acute abscesses are diagnosticated by the history of preceding acute inflammation, the superficial œdema, the throbbing pain, the appearance of pointing, the sense of fluctuation, and in cases of doubt by the use of an exploring needle or by the withdrawal of some of the pus with a hypodermic syringe or aspirator. Chronic abscesses are distinguished by the absence of symptoms pointing to aneurism, cystic tumors or malignant growths, by the negative history, the possibly depraved constitution of the patient, œdema, fluctuation, and by aspiration. Fluctuation is the wave caused by the displacement of fluid when pressure is suddenly made upon the swelling. It shows the existence of liquid contents, but gives no indication of their character. It may be obtained by placing the fingers of the two hands on opposite sides of the suspected abscess and making intermittent pressure or striking sudden taps. In small collections it is better to grasp the swelling between the thumb and fore-finger of one hand, and make the parts tense, while intermittent pressure is made by the fore-finger of the other hand. The transmission of the impulse proves that the contents are fluid, but other symptoms

must be investigated to determine whether pus, serum, or blood is contained in the tumor.

The opening of an abscess must always be an aseptic procedure. After the incision the interior of the sac should be thoroughly scraped out with a curette and made perfectly aseptic by means of irrigation. This removes all pus and microörganisms. The cavity, if small, may then be sewed up so as to bring the walls together and allow healing. If the abscess be a large one it may be needful to provide for drainage by the use of drainage-tubes. This is especially necessary in large cavities that cannot be thoroughly scraped and disinfected. Dressings should be *anti*septic in character, as a rule, and should exert some pressure so as to cause collapse of the walls of the cavity.

Treatment.—Since abscess is the result of mycotic inflammation, the local and constitutional means previously described, as appropriate for the cure of inflammation by resolution, should be adopted when suppuration is threatened. A blister is often very serviceable, and seems to dissipate the suppurative inflammation. If it is found that resolution is impossible, rapid maturation and evacuation of the abscess are to be obtained, and restoration of the parts to a normal condition promoted. Hot and moist applications, such as poultices, soften tissue and encourage rapid migration of leucocytes; hence, they are, perhaps, proper when resolution and absorption seem hopeless. Poultices are very little used since the advent of the antiseptic era, and more early operative interference than formerly is usual. To relieve the pain and tension, and prevent disfiguring scars and destruction of tissue, early evacuation, by means of a free incision made with a *sharp* knife, is imperatively demanded in all cases of acute abscess. Incision made before pus has actually formed will often cut short the suppurative process, and, if made sufficiently free to relieve tension, always lessens the pain. If there is danger of wounding large vessels the abscess may be opened on a grooved director, or it may be torn open with a blunt instrument after incision of the skin. Sometimes this last procedure is well done by inserting the end of a pair of closed forceps and forcibly opening the ends of the blades. In all cases where the cavity is large the orifice should be kept open by a tent made of a piece of antiseptic gauze, or by a drainage tube; and permanent pressure should be applied by means of a bandage, in order to hasten contraction and granulation of the sac of the abscess. Counter-openings may be necessary when the pus infiltrates the connective tissue or burrows or gravitates into pouches which prevent its ready escape.

In tubercular abscess the treatment is the same. The evacuation of many fluidounces of puriform liquid may, by exposing the wall of the abscess to the air with its septic influences and by the sudden relief of pressure to which the surrounding capillaries were accustomed, lead to rigors, exhaustive fever, and grave constitutional symptoms. Hence, as the fluid is sometimes, though very rarely, absorbed, and chronic abscesses may remain without pointing for indefinite periods, it was formerly the custom with many to abstain from operative interference. This is injudicious, for withdrawal of the so-called pus by the aspirator, and the application of firm pressure, or incision and disinfection under the strictest antiseptic precautions, are now believed to be the best surgery.

Hyper-distention of large abscess cavities with antiseptic solutions forced in by means of a syringe tightly fitting a small opening, is often a good procedure to be adopted as soon as most of the contents have been allowed to escape. Thus air is excluded, the customary pressure main-

tained, and constitutional symptoms lessened. These various antiseptic measures are useful in acute abscesses, but are even more essential in large chronic abscesses. Supporting remedies and anodynes are important in all cases of severe or prolonged suppuration.

The local treatment of all abscesses, then, whether acute or chronic, should be early and free incision with strict antiseptic precautions. The best watery solutions to use in washing out small abscess cavities are corrosive sublimate (1 : 1000 to 1 : 5000) and betanaphthol (1 : 2500). As there is some risk of poisoning if large quantities of the sublimate solutions remain in large and irregular cavities, that drug must be used with caution. Betanaphthol is not poisonous, but is not so active a germicide. Solution of iodoform in ether (1 : 50 to 1 : 500) is a good material for injecting the cavities of tubercular abscesses. In all cases the solution, of whatever character, is subsequently allowed to flow from, or is pressed out of, the abscess cavity.

Sinus and Fistula.

When an abscess has been evacuated it may not contract and heal completely, but, especially when the muscles prevent perfect rest, may leave a long, narrow, and sinuous canal through the tissues. This is lined by a membrane having somewhat the character of mucous membrane, from which unhealthy pus is discharged. If the canal has only one orifice it is called a sinus; if more than one, a fistula or fistule. The term fistula in surgery is sometimes limited to such a canal communicating with one of the hollow organs, as the bladder, rectum, or lachrymal sac. The orifice of a fistula or sinus is usually surrounded by exuberant granulations projecting as a papilla. Sinuses and fistules are cured by destroying the adventitious lining membrane and setting up acute inflammation, in order to cause healthy granulations to take place from the bottom. This may be done by irritating injections, the actual cautery, curetting, or by laying the track open with the knife or elastic ligature which thus controls all muscular contraction; and in many cases still better by dissecting the whole canal out and approximating the healthy wound so made with sutures. Any source of irritation, such as diseased bone or foreign material, must be removed at the same time.

The term fistule is also applied to a communication between two hollow viscera, due to injury or sloughing. Such abnormal openings are cured by plastic operations.

Ulceration.

When inflammation does not terminate by resolution in a return to health, death of the part by either ulceration or gangrene must take place. Ulceration is death in small particles or molecules; gangrene is death in masses large enough to be seen. Similar processes in osseous tissue are called caries and necrosis, and will be described under diseases of bone. The causes of ulceration are the same as the causes of inflammation, to which ulceration always owes its existence. It may occur superficially, as in the skin and cornea, or deeply, as in the substance of organs, for abscesses and sinuses are practically but the results of ulceration. The ulcerative process is more common in skin, mucous membranes, cartilages, lymphatic glands, lungs, and bone (called caries), than

in fibrous, serous, or muscular tissue. Ulceration consists in softening and disintegration of structure, followed by the removal of the débris by absorption and ejection. When removal of tissue is effected by absorption alone, as is seen in erosion of tissue from aneurismal pressure, the term interstitial absorption is applicable, since ulceration causes removal chiefly by discharges.

Ulceration and suppuration are closely allied, since some of the pus owes its existence to the destruction and disintegration of tissue. Sloughs and foreign bodies in the tissues are usually thrown off by ulceration and suppuration occurring around them.

Ulceration, then, is the molecular death of soft tissues, and produces on a free surface the anatomical lesion called an ulcer or open sore.

Ulcers.

Definition.—An ulcer is a breach of continuity of surface, covered by granulations and usually accompanied by a discharge of pus. The nature of the granulations and of the pus determines the character of the ulcer. The solution of continuity may be due to the process of ulceration, to gangrene, or to a wound; for in gangrene the slough is separated by ulceration, and wounds that do not heal by first intention become ulcers as soon as granulation is instituted. A solution of continuity called an ulcer is usually deeper than the epithelium; if not, the terms abrasion, desquamation, or excoriation are commonly applied. Among exceptions to this rule may be mentioned superficial ulcers of the cornea.

Surgeons are called upon to treat ulcers of the skin and mucous membrane, and to these alone are the following paragraphs meant to apply.

Varieties.—All ulcers are direct consequences of the inflammatory process, which is due to either constitutional or local causes. The causation is an important factor in the treatment of ulcers, but does not require any change in the classification of them.

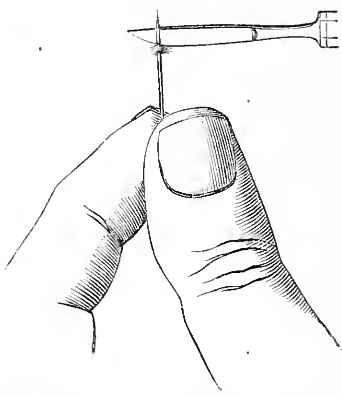
Ulcers are healthy or unhealthy. The healthy ulcer is typically illustrated by the sore produced when granulation has begun in a wound made by cutting out a portion of tissue. The edges are regular and smooth, and slope gradually toward the granulations, which are red, painless, do not bleed under gentle pressure, secrete a serous non-purulent fluid, and never protrude above the surface of the skin. The granulations at the circumference are being covered by or converted into a bluish-white cicatricial pellicle of epithelium, while the skin surrounding the ulcer is purplish and somewhat hardened by inflammatory infiltration. All ulcers must be brought to this condition before cicatrization can occur, and so long as the ulcer continues healthy, healing goes on spontaneously and steadily if the surface be only protected from injurious contact. Protection is best effected by applying a piece of aseptic rubber tissue or oiled silk covered with an aseptic or antiseptic gauze dressing. Some surgeons prefer antiseptic ointments, such as carbolized oxide of zinc ointment, boric acid ointment, and ointment of petroleum; or lotions or powders containing some germicidal agent.

Unhealthy ulcers are those accompanied by some condition which prevents their exhibiting the characteristics above mentioned. If undue inflammation be present, as shown by great heat and pain, œdematous surroundings, engorged granulations, and discharge of pus mixed with blood, it is an inflamed ulcer. If this process be violent and rapid, de-

struction of tissue and extension of ulceration occur, a pellaceous mass is seen covering unhealthy-looking granulations, and the edges become irregular and sharp-cut. This constitutes a "sloughing" ulcer, which is a rather contradictory term. The devitalized skin or muscle is often found in the discharge from such an ulcer, as shreds and tags of tissue.

When the granulations are exuberant and project like excrescences beyond the level of the skin, the ulcer is called a fungous ulcer. The callous or indolent ulcer is deeply excavated, has indurated whitish and undermined or inverted borders, is surrounded by thickened and congested skin of a bluish color, shows imperfectly-formed pale granulations covered with a foul-smelling thin pus, and is usually insensible to painful contact. Such ulcers are of long duration, and may well be termed chronic. Ulcers may be complicated or may depend upon the existence of varicose veins, impeded circulation, diseased bone, or may be the seat of hemorrhage or of malignant processes. Other circumstances may contribute to the production of complicated or unhealthy ulcers, but it is not necessary to give a distinctive name to each one.

Fig. 2.



Method of cutting skin-grafts by means of needle and scalpel.

Ulcers, otherwise healthy, are often the seat of a purulent discharge, because of pyogenic germs having been allowed to come into contact with the ulcers' surfaces. Such a suppurating ulcer is usually denominated a healthy ulcer, though the term is not strictly applicable.

Treatment.—The criterion in the treatment of all ulcers is the condition of the edges. If the borders are pinkish and smooth, and gradually slope down to florid granulations, or perhaps are separated from them by a narrow line of bluish-white epithelial cicatricial tissue, it is certain that the ulcer is in a healthy state, and only requires protection from irritation. Hence, it may be dressed with any bland non-irritant application. Carbolized ointment of the oxide of zinc is, in my opinion, one of the best, if the ordinary aseptic protective silk, or rubber, and gauze dressing is not used. Cicatrization usually takes place from the edges toward the centre, and therefore in large ulcers, even when healthy, the action of the cutaneous cells at the margins may be insufficient to complete the process, or if able to do so, may be very slow in causing healing of the entire ulcerated surface. Centres of cicatrization may be established upon the ulcer at any number of points by applying aseptic grafts of skin (Fig. 3).

Skin-grafting is best performed by thrusting the point of an aseptic ordinary sewing-needle under the epidermis of the inner surface of the arm or thigh, previously made aseptic, and, after putting the skin on the stretch by raising the needle, cutting out a minute portion of the true skin with a sharp scalpel or scissors. The graft taken in this almost painless and bloodless manner is then to be gently pressed upon the healthy granulations with its epidermic surface upward and a gauze dressing applied. Any number may be engrafted. The grafts at first shed their cuticle and become almost invisible, but in a few days bluish-white

spots of cicatricial tissue are seen at the points where some grafts have taken root. These islands grow eccentrically by epithelial cell proliferation, and stimulate the periphery of the ulcer to similar activity, so that the cicatrizing process is greatly expedited by the new points of cutification, which gradually coalesce with one another and with the marginal skin. The process is not attended with much success unless the ulcer be healthy. Long and thin shavings of skin cut from the patient by means of a sharp razor may be used in a similar way. This method causes much more rapid healing, but the pain is rather severe when the shavings are cut. Skin may be taken from a living frog's abdomen and laid upon the ulcer. Plastic operations may be performed to hasten the healing of intractable ulcers by the transfer of healthy integument to their surfaces.

FIG. 3.

Skin-grafting in traumatic ulcer of the scalp. (LEVIS.)

The treatment of all unhealthy ulcers must be directed to transforming them into healthy ulcers, and is both constitutional and local. If they depend upon syphilis specific remedies, such as mercury, iodoform, and the iodides, must be given internally; if the tuberculous diathesis exist, iodine and its derivatives, cod-liver oil and tonics, are required. In all cases digestive and other constitutional vices must be investigated and treated. Any local exciting cause, such as bone disease and varicose veins, must be removed, or at least palliated, after which local treatment is to be regulated by the condition of the ulcer. An ulcer accompanied by acute inflammation must be managed on the principles already laid down in the treatment of acute inflammation. Antiphlogistic internal remedies are demanded, while elevation and rest of the part, scarification,

lead water and laudanum, warm water dressings, or weak astringent solutions are used locally. When the inflammation is severe enough to cause sloughing ulceration, supportive treatment and poultices to hasten separation of the sloughs, or other mild applications are demanded. The local irritability and pain which characterize many ulcers are often greatly lessened by the application of solid nitrate of silver, or strong solutions of the same (gr. xx to f℥j of water). Subnitrate of bismuth is an excellent local remedy. A moist antiseptic gauze dressing, covered with oiled silk or rubber tissue to prevent evaporation, is far better than the old-fashioned poultice. It is, in fact, an antiseptic poultice.

Fungous ulceration is treated by caustics, such as deliquesced chromic acid, or by the surgeon cutting away the exuberant growth with the knife, or scraping it away with a sharp spoon. Ulcers exhibiting pale, œdematous, semi-transparent granulations require stimulating applications of nitrate of silver and sulphate of copper, in solution or undiluted.

Callous or indolent ulcers are the most rebellious to treatment. The hard elevated edges must be softened and depressed, and the accompanying venous congestion, shown by the livid skin surrounding the sore, removed. My own plan is to apply pure carbolic acid, nitric acid, or some other chemical cauterant, to the insensitive edges and to the foul and semi-devitalized tissue covering the depressed and unhealthy granulations. Then a moist antiseptic dressing is applied for a few days to separate the slough thus produced and to soften the callous borders. Subsequently scarification around and through the ulcer relieves the engorged venous capillaries. The pressure of strips of adhesive plaster properly adjusted, or of an elastic bandage smoothly applied from the distal extremity upward, prevents a repetition of the congestion, and stimulates absorption of deposits and cicatrization of the ulcer. Instead of using the caustic, I frequently get rid of the callous margins by paring them away, and then treat with antiseptic dressings and pressure, or the whole ulcer may be scraped away with a curette and treated as a recent wound. Astringents and disinfecting lotions may be used beneath the elastic bandage. Chronic ulcers of small size may be frequently cured with rapidity by dissecting them out, freeing the surrounding skin from its deeper attachments, and uniting the edges of the wound by sutures.

Peroxide of hydrogen is said to render a foul ulcer aseptic by oxidizing the devitalized and putrefying discharges.

Tubercular ulcers do well when treated with powdered iodoform.

As soon as unhealthy ulcers approach the healthy condition cicatrization begins, and may be hastened by skin-grafting. In order to maintain a healthy state of the sore and prevent œdematous and fungous granulations, slightly stimulant lotions of chloral (gr. v or x to f℥j), sulphate of copper (gr. iij–v to f℥j), sulphate of zinc (gr. v to f℥j), or nitrate of mercury or subnitrate of bismuth in solution, ointment, or powder should be employed. When in a few days or weeks the ulcer gets accustomed to the effect of one agent and becomes "inactive," the dressing must be varied, for a new impression will be beneficial. Mucous ulcers are to be treated like cutaneous sores.

Mortification, or Gangrene.

Definition.—Mortification, or local death, is the complete and permanent cessation of vital functions in a part, and differs from ulceration in the devitalized portion being more extensive. Ulceration is molecular

death, while mortification is death of appreciable areas of tissue, that is, of tissue in mass. The two processes are, however, allied, and may co-exist, as in hospital gangrene or sloughing phagedæna, where ulceration is too rapid for disintegration to take place. The dead tissue is called a slough or eschar. Necrosis is often used by pathologists to signify death of animal tissues in mass without reference to the character of the structures, but in surgery, necrosis is usually applied to bone and cartilage; and mortification, gangrene or sphacelation to soft tissues.

CAUSES.—Mortification is due to defective nutritive supply and to destruction of cellular activity. The former condition may be caused by obstruction in the arteries, as from ligation, rupture, embolism, plugging by great numbers of bacteria, or diseased arterial walls; obstruction in the veins, as from tight bandaging; obstruction in the capillaries, as from pressure of tumors, or inflammatory deposits; cardiac weakness, which is merely an accessory cause, decreasing the activity of the circulation; inflammation, by its intensity inducing permanent arrest of circulation, or by its specific mycotic cause having a special tendency to cause destruction or devitalization of tissue.

The causes which induce mortification by destroying the vitality and activity of the cellular elements are: injuries, which disorganize tissue; chemical agents, such as acids and alkalies; the ptomaïnes of putrefactive or other bacteria acting as irritants; and excessive heat or cold. Mortification is often due to a combination of several of the causative influences. Defective innervation has been considered a cause of mortification, but it is probable that it acts only indirectly by diminishing circulatory activity, or by rendering parts less cognizant of the contact of irritating agents. The power of the cells to resist gangrenous causes varies in individuals and in tissues.

VARIETIES.—Mortification may be moist or dry, according to the causation and circumstances attending the process. If the parts contain much fluid, as is the case when the mortification is associated with venous obstruction and when evaporation is prevented by the integrity of the cuticle, the process resembles the ordinary putrefaction of animal substances as seen in dead bodies. This is called moist gangrene. The local symptoms are due to the fact that ordinary putrefaction is occurring because putrefactive fungi have gained access to the dead tissue through the skin. If the gangrene is due to slowly progressive arterial obstruction while venous and lymphatic absorption is not decreased, or if rapid evaporation occurs on account of the destruction of the cuticle, the parts become shrivelled and dry, and dry gangrene is said to exist. Acute gangrene is usually moist, because it dies quickly when full of blood, while chronic mortification is generally dry. Soft and vascular tissues mortify much more rapidly than dense, non-vascular structures, such as tendons and cartilages.

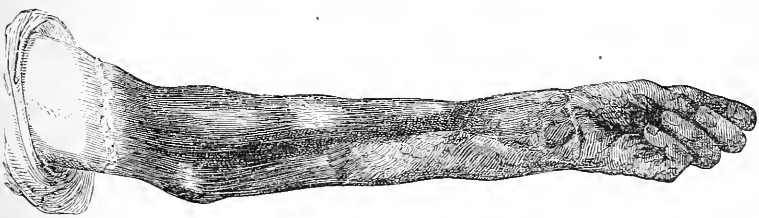
The infarctions found after embolism of renal and other arteries, the caseous change that occurs in scrofulous products, and similar pathological conditions, are examples of what has been called *coagulation-necrosis*, which is a change of protoplasm into a material resembling the fibrin of the blood. With this form of mortification surgical pathology has little concern.

SYMPTOMS.—The constitutional symptoms of gangrene are almost invariably asthenic, probably because the blood becomes deteriorated by the admission of septic products derived from the sloughing tissues.

The feeble circulation and general nervous depression accompanying a very limited area of mortification are often remarkable.

The local symptoms of moist and dry gangrene differ and must be discussed separately. In the moist variety the parts become green, bluish, or black, lose their normal sensibility and temperature, and become softened and covered with blebs containing reddish-brown fluid. The epidermis is easily rubbed off, leaving a dark, smooth surface. Pressure causes a crackling sound, due to the presence in the tissue of the gases generated by putrefactive decomposition. The gases, which are principally sulphuretted hydrogen, ammonia, and carbonic acid, cause great local emphysema and puffiness of the parts, and with the other products, such as butyric acid, give the characteristic odor of putrefaction. The red streaks along the course of the vessels in the incipiency of gangrene, and the deep color of the parts during its existence are due to the transuded coloring matter liberated by the destruction of the blood corpuscles.

Fig. 4.



Senile gangrene of arm.

In dry gangrene the appearance of a small brown or black spot, especially upon the toes, where the affection is most frequently seen, is often the first sign of disease; though at times cramps, and stinging pain, and feeble local circulation are premonitory symptoms. The discolored point, instead of being brown may be a mottled white, and sometimes a vesicle forms at the beginning of the disease. The darkened area becomes blacker and slowly extends with very few accompanying inflammatory symptoms. The dead tissue is dry, without offensive odor, and gradually becomes shrivelled and hard. The loss of sensibility and the lowered temperature of the dead tissue present in moist gangrene, of course, exist here. This form of mortification is frequently called senile gangrene, but improperly so, since it may occur from chronic ergotism without reference to the patient's age, and because moist gangrene may occur in the aged in similar regions of the body.

In all forms of mortification, if the patient survive long enough, the dead tissues are separated by the process of ulceration from those whose vitality resists the destructive influence. The living structures become reddened at the line of junction with the slough, and thus constitute the line of demarcation which indicates the extent to which the devitalizing process has been able to exert its influence. Sometimes a row of vesicles forms along this margin. The line of demarcation soon becomes converted into a groove which is lined by granulations secreting pus. This is practically a linear ulcer, and is called the line of separation, because the ulcerative and granulating processes gradually push off the dead tissues by a species of natural amputation and leave an ulcer to heal by cicatrization. Hemorrhage is prevented by coagulation within the

arteries and fibrinous deposition due to the inflammatory action. The inflammation accompanying mortification often gives rise to great pain, which, of course, is located in the living or partially devitalized structures. This increases the general depression due to septic influences of the gangrenous parts. When mortification occurs in deep structures, the slough is thrown off through fistulous orifices, as occurs in carbuncle, and as is attempted by nature, though often unsuccessfully, in necrosis of bone; or, it may become encapsulated and thus be separated from the surrounding living structures. The latter mode of separation is seen in infarctions of the internal organs.

Treatment.—The general treatment of all forms of gangrene, to be judicious, should be directed to fulfil two indications: first, to remove the cause and thus arrest the progress of the gangrenous action; and, secondly, to sustain the patient until separation of sloughs has occurred. Unfortunately, the constitutional cause is often difficult of removal, but an effort should be made to bring the system into that condition which will render the causative factors as inoperative as possible, and limit the mortification. If the peripheral circulation is poor because of a feeble heart and degenerated arteries, remedies such as quinia, iron, opium, digitalis, strychnia, alcohol, etc., should be administered and the patient protected from cold and other depressing influences. When there is a tendency to a sthenic type it is possible that slightly depressing agents *may be* advantageous, but these are seldom needed and should be used with great caution, since the advent of gangrene is soon followed by nervous and circulatory prostration.

During the stage of separation of sloughs the flagging powers of the patient must always be supported by active medication with tonics, stimulants, and concentrated nutritious diet. Depressing antiphlogistic remedies are never justifiable; and if nervous irritability and pain exist opium in full doses is to be employed. Cleanliness, disinfection, and ventilation are necessary hygienic measures. The local treatment of mortification is very important.

If gangrene is threatened on account of the tension produced by rapid and intense inflammatory swelling, it may often be averted by free incisions several inches in length through the skin, subcutaneous and fascial structures. This treatment relieves local tension by permitting gaping of the wound and affording a free escape of blood and inflammatory products. Much tissue destruction is thus avoided by removing the obstruction to capillary circulation. Parts prone to slough from deficient circulation should be kept normally warm. When gangrene has occurred disinfectant lotions of carbolic acid of an unirritating strength (1 : 20 or 30), corrosive sublimate (1 : 1000 or 3000), chlorinated soda, chloride of zinc (1 : 50 or 100), or desiccating powders of a disinfectant nature, should be used to destroy the fetor of the parts. These should be combined with antiseptic gauze dressings, perhaps made moist and covered with oiled silk or waxed paper, in order to encourage and hasten separation of the devitalized tissues. The sloughs may be removed in pieces with the forceps and scissors after the line of separation has divided the vascular attachments. Tendons and fibrous tissues, as they contain no vessels of importance, may be carefully cut, for in this manner the decomposing masses can be removed somewhat earlier. No special dressing is to be applied to the line of separation. The ulcer left after the slough has been detached is to be dressed with mild applications, such as carbolized oxide of zinc ointment, ointment of petroleum and boric acid, or

antiseptic gauze, as in ordinary ulcers. Cicatrization is to be encouraged.

When mortification depends on a known local cause, such as crushing of the parts, or ligation or rupture of the main artery, amputation should be performed, except in cases due to frost-bite or burns above the location of injury, without waiting for the line of demarcation. If the gangrene is due to constitutional causes, such as deficient circulation, or ergotism, or to the presence of an embolus whose location is unknown, the surgeon must wait until the line of separation is well marked before attempting operative interference, since the extent of the gangrenous influence cannot otherwise be estimated. In traumatic cases where gangrene is inevitable, amputation should be promptly performed.

Hospital Gangrene.

Hospital gangrene, or sloughing phagedæna, is a peculiar form of rapidly spreading mortification or gangrenous ulceration, which attacks wounds or injuries where the epidermis is broken, when patients are subjected to the foul air of overcrowded hospitals and the wounds infected by certain bacteria. It is exceedingly contagious and infectious, and may at times begin as a vesicle if the parts are not much denuded of cuticle. The ulcer resulting is painful, covered with grayish sloughs, and discharges excessively fetid, brownish fluid. The edges of the ulcer, as a rule, are sharply cut. The connective tissue is rapidly invaded, and profuse hemorrhage may occur. The constitutional symptoms, which are secondary, are markedly asthenic. The disease is of local origin, due to wound infection, and must be treated as such. The patient should at once be removed to uninfected quarters, such as a tent, or pavilion hospital, and all the instruments, dressings, and sponges be sterilized or destroyed. The sloughs should be lifted off, if possible, and the entire wound saturated with undiluted nitric acid, bromine, or other powerful cauterant to destroy the septic germs. The caustic must corrode the healthy tissue in order to get beyond the gangrenous influence. The actual cautery is probably valuable in such cases. Tonics, stimulants, and other supportive treatment generally combined with opium are required internally.

Fortunately, the aseptic and antiseptic methods of modern surgery have made hospital gangrene practically unknown.

CHAPTER III.

ERYSIPELAS, SAPRÆMIA, SEPTICÆMIA, ETC.

ERYSIPELAS.

Description.—Erysipelas is an acute febrile affection, usually of a low type, due to some mycotic blood contamination, and accompanied by a rapidly spreading inflammation, which has no tendency to limit itself by the exudation of plastic matter. It is most frequently met in the tegumentary structures, but may attack mucous and serous tissues as well. As seen by the surgeon it generally occurs as a complication of wounds, but may arise idiopathically. Simple or cutaneous erysipelas involves the skin alone, while in the phlegmonous or cellulo-cutaneous variety the subcutaneous tissue is also inflamed. If the inflammatory process spreads through the cellular or connective tissue without invading the skin, it is called diffuse cellulitis or cellular erysipelas.

It is an infectious and contagious disease, and is particularly liable to attack those debilitated by bad hygienic surroundings or depressed by intemperance or by renal and hepatic affections. The septic germs contained in putrefying dead bodies have some occult influence in the induction of erysipelas. It appears to be allied to septicæmia, and also follows bites of venomous reptiles, etc. It is uncertain whether it is due to a special vegetable parasite, or results from the streptococcus, which causes diffuse suppuration. Many believe that suppuration occurring in the course of erysipelas is indicative of a secondary infection with pus fungi.

Symptoms.—The constitutional symptoms may be of a sthenic type, but unless the disease is very mild and short in its course, they soon present the characteristics of asthenia. Fevers, rigors, nausea, vomiting, coated tongue, constipation, and perhaps delirium, are the early symptoms, which are not lessened by the appearance of the eruption, and are followed by frequent quick pulse, muttering delirium, dry tongue, sordes and often by diarrhœa, and not very infrequently by death. In the cutaneous and cellulo-cutaneous forms the burning or throbbing pain, the scarlet, or dusky-red, shining skin, with a distinctly elevated margin, the œdematous or brawny character of the swollen part, the tendency to spread, and the lymphatic glandular involvement, make the diagnosis sufficiently distinctive. Vesicles may form and be succeeded by a brawny desquamation. Sometimes in the cellulo-cutaneous variety suppuration or gangrene of the connective tissue occurs; then the skin is apt to become less scarlet in color, and the parts have on palpation an œdematous or boggy feel. There is no sign of pointing, but incision discloses a diffuse form of abscess in the areolar tissue, and gives escape to shreds of gangrenous tissue and unhealthy, foul-smelling pus.

When erysipelas attacks a wound the pus from it becomes lessened, the granulations degenerate, the union breaks down, and the local symptoms, mentioned above are presented about the wound. Cellular erysipelas, often called diffuse cellulitis, resembles the cellulo-cutaneous variety, but usually arises secondarily to a wound, and presents fewer characteristics of inflammation of the skin. Its evident relationship to erysipelas is

admitted, but the term cellulitis seems preferable to cellular erysipelas. This variety of erysipelas may attack the areolar tissue in the pelvis and other internal regions if they be opened by a wound. The probability of causing puerperal septicæmia by inoculation from erysipelatous cases must always be borne in mind by the obstetrician or surgeon.

An attack of erysipelas lasts from one to two weeks, and in persons of fair health previously, is usually followed by recovery. The subcutaneous forms have a much more unfavorable prognosis than the cutaneous.

Treatment.—Preventive measures consist in ventilation and sterilization of instruments and dressings. At first a purge should be given and light diet ordered, but, as a rule, depressing treatment is inapplicable, because the disease soon assumes a low type. Hence ten minims of tincture of iron every two or three hours, combined, perhaps, with two grains of quinia at each dose, is the best treatment. Opiates and stimulants may be demanded. Milk and beef essence, or meat juices, are the best articles of diet. A mixture of one part of laudanum, one part of lead-water, and two parts of water, a combination of lime-water and sweet oil, or a non-irritating antiseptic lotion or ointment, should be applied locally. If suppuration and gangrene threaten, or if great tension is present, numerous incisions, which will gape widely, should be made aseptically, and be followed by antiseptic gauze dressings. When pus burrows, as in the subcutaneous forms of the disease, the cavities should be injected with carbolized water (1 : 40), or solution of corrosive sublimate (1 : 2000), and drainage-tubes inserted and counter-openings made.

Sapræmia, Septicæmia and Pyæmia.

Definition.—There are four conditions often confused which ought to be distinguished; though it is admitted that a clinical diagnosis is frequently impossible.

They are:

1. *Aseptic wound-fever*, arising in connection with aseptic wounds, and due, probably, largely to poisoning by the so-called fibrin ferment. This is given off during the disintegration of leucocytes which occurs in inflammation at the time the exudate coagulates. The inflammatory fever usually seen is, however, one of the forms of septic poisoning mentioned below, and is due to imperfect asepsis. If the wound is absolutely aseptic the wound-fever is always inconsiderable.

2. *Sapræmia*, putrid poisoning, or septic intoxication, which is a febrile condition, due to the chemical products or ptomaïnes developed by putrefaction of animal tissues, either in the wound or entirely away from the body of the patient. This poison may gain access to the blood by its development and retention in insufficiently drained putrescent wounds; or, it may be obtained experimentally and be injected hypodermatically. The poison is the result of mycotic action, of course, for putrefaction is due to fungi of putrefaction. The symptoms of sapræmia occur immediately after inoculation, but it requires a comparatively large dose to produce a toxic effect.

3. *Septicæmia*, or septic infection, a fever due to infection by putrefactive microörganisms which enter the blood by the mucous membranes or by a wound, usually by the latter, and do not produce symptoms until they have had time to multiply. The clinical symptoms are similar to those of sapræmia, but a most minute dose is sufficient to lead to violent

symptoms. The condition formerly called hectic fever corresponds with what is now called sapræmia and septicæmia.

4. *Pyæmia*, a condition in which the general febrile disturbance, similar to septicæmia, is due to pyogenic germs, and in which secondary foci of inflammation or suppuration, called metastatic abscesses, are formed in the lungs, liver, and other organs. These abscesses in distant organs are due to the transportation in the blood-stream of emboli infected with pus-causing bacteria. Pyæmia is probably simply a multiple suppurative inflammation. The old theory that pyæmia is a condition in which the blood contains pus is untenable, though the derivation of the word pyæmia still suggests it.

The relations of sapræmia, septicæmia, and pyæmia are not perfectly understood. They may, therefore, be considered together, at least until their clinical relations and pathology are further investigated. Some authors believe pyæmia to be identical with what I have called septicæmia, except that the poisoning is more intense.

Pathology.—The peculiar poison, which by introduction into the blood causes sapræmic conditions, is associated with putrid decomposition of albuminous fluids, and is connected with the production of ptomaïnes by the bacteria causing the putrefactive process. Septicæmia and pyæmia are due to infection by microörganisms themselves; the former by the microörganisms of putrefaction, the latter by the microörganisms of suppuration. It is usually necessary that there exist some abnormal state of the tissues, such as inflammation, before the presence of such microbes can induce these conditions. The occurrence of septicæmia and pyæmia is promoted by such conditions as favor the contact of wound surfaces with particles of decomposing animal tissue, or of dust containing pyogenic bacteria, such as necessarily circulate in ill-ventilated apartments containing numerous surgical patients. Septic and infective substances thus introduced into animal fluids encourage therein putrefactive changes and the generation of infecting organisms. It is necessary, however, in order to infect the system, that the poisonous principle be absorbed. A recent wound, or one covered with unhealthy granulations, allows rapid absorption of the poisonous substances, while healthy granulations seem to act as a barrier to septic infection. The blood in septicæmic conditions is less coagulable than in health, and the red corpuscles show a tendency to congregate in irregular masses, and to undergo ante-mortem disintegration. In addition, congestions of organs and stasis of the blood-current are frequently observed. The autopsy frequently shows softening and degeneration of viscera, ecchymosis and even inflammation of the serous membranes, and changes in the glands and mucous membrane of the intestines.

Pyæmia may be provisionally considered as septicæmia with the addition of disseminated spots of inflammation and suppuration. These consist of metastatic abscesses in lungs, liver, spleen, and other viscera, due to embolism and bacterial infection, and suppuration in joint cavities or inflammation of cellular and serous tissues, caused either by embolism or the blood-change. Metastatic abscesses commence as small, reddish, and usually pyramidal sections of solidified tissue, which are found most frequently near the periphery of the lungs, liver and spleen. These soon break down into pus, producing abscesses, which are always small, and which are surrounded by indurated tissue. These multiple or metastatic abscesses result from the process of embolism as follows: At the seat of the original inflammation coagulation takes place in the vessels, and on

account of puriform softening of these clots or thrombi, due to septic influences, small particles of the thrombi, are washed into the circulation, carrying along with them pyogenic bacteria. These emboli lodge in the capillaries of the lungs or other viscera, cause impairment of circulation, and by their mycotic nature give rise to numneous suppurative points called metastatic or embolic abscesses.

FIG. 5.

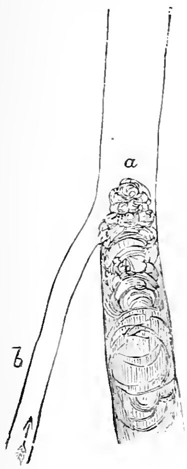
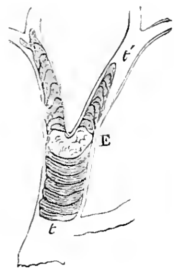


Diagram of thrombus in a vein. *a.* central end of a venous thrombus projecting into a large trunk. *b.* small branch. The blood flowing from small branch may readily detach a part of the thrombus. (BILLROTH.)

FIG. 6.



Embolus (E) impacted at the bifurcation of a branch of the pulmonary artery. Secondary thrombi (*t* and *t'*), behind and in front of embolus, extending to the first collateral branches. (VIRCHOW.)

Pyæmia is probably not an actual disease, but simply a transference of suppuration by means of emboli and their accompanying pus-causing germs. It is a complication, or variety, then, of suppurative inflammation; due perhaps to putrefactive germs having caused softening of the thrombi. Hence the frequent association of septicæmic conditions and pyæmia.

CAUSES.—The exciting cause of septicæmia is the peculiar poison already described as usually generated by the mycotic decomposition of albuminous fluids. The poison, under the name of sepsin, is believed to have been isolated; but our knowledge of the nature of the agency inducing septicæmic conditions is very limited. Any condition which tends to produce septic material in the patient's body may be called a predisposing cause. The most frequent of all is the existence of a wound, though it is possible that septicæmia may result from septic changes in the fluids of the body, due to agencies introduced by absorption through the mucous membranes. Hemorrhage, protracted shock, erysipelas, osteomyelitis, puerperal lesions, overcrowding of patients affected with suppurative diseases, and bad hygienic surroundings are important predisposing causative factors.

Symptoms.—The first symptom of septicæmia or of pyæmia is often a sudden rigor preceded or accompanied by a rise in temperature, which is followed by exhaustive sweating with rapid lowering of bodily temperature. These phenomena resemble those of malarial fevers, but the hot stage between the rigor and the sweating is less marked. The temperature during the chill may rise to 104°–107°, and during the sweating period may fall, though rarely, to normal or below. The rigors and great temperature changes are repeated at more or less irregular intervals. The pulse is increased in frequency, but diminished in force, beating 90–120 per minute; and respiration is similarly affected, being more frequent and less deep. The breath and emanations from the body have a sweetish odor which is of some diagnostic value in septicæmic states. The tongue is usually furred, while nausea, vomiting, and diarrhœa are frequently present. The skin, which has a pale or yellowish hue, due to pigment from disorganized corpuscles, may present sudamina, and even an ecchymotic or a pustular eruption. Albuminuria is not infrequent and delirium is common. As the disease progresses the symptoms assume the asthenic or typhoid character as shown by rapid emaciation, great exhaustion, twitching of the tendons, drowsiness, low muttering delirium or coma, dry and brown tongue, sordes upon the teeth, colliquative diarrhœa and sweating. The wound during this time usually, but not always, assumes an unhealthy character of granulations and discharge. In most cases the discharge of pus decreases, and it may entirely disappear. About the sixth or tenth day, if pyæmia and not mere septicæmia exist, the formation of metastatic abscesses and the occurrence of other inflammatory foci give rise to jaundice, cough, pain which is often intense in the joints, and suppurative or inflammatory signs in the viscera and elsewhere.

The lobular pneumonia, hepatitis, pleuritis, pericarditis and other inflammations that at times occur, give rise to their characteristic symptoms. The prognosis is always unfavorable, as in acute cases death takes place, as a rule, in from one to two weeks, and in chronic cases in from one to two months. Recovery, however, does at times occur after a protracted convalescence. It is often impossible to discriminate between cases of septicæmia and pyæmia until the autopsy proves or disproves the existence of metastatic abscesses. The symptoms have, therefore, been grouped together as representing conditions which are often indistinguishable during life.

Diagnosis.—Septicæmia or pyæmia may be confounded with malarial or typhoid fever. The suddenness and intensity of the rigor and of the temperature rise, the irregular occurrence of these phenomena, the great fall in temperature, which seldom reaches the normal before the occurrence of another rise, the profuse sweating which follows the rigor without the intervention of a marked hot stage, and the association of these symptoms in many instances with a wound, usually serve to render a differential diagnosis possible. Quinine will usually modify malarial conditions but not septic ones. Ordinary inflammatory fever differs from septicæmia because it usually ceases when suppuration begins. Rheumatism is at times distinguished with difficulty from chronic pyæmia, but the acute forms of the diseases differ, because rheumatic effusion into the joint cavities is seldom purulent as in pyæmic synovitis. Again, the sour odor of acute rheumatism is replaced by the sweetish smell often noticed about septicæmic cases. The rapidity of emaciation and the fatal issue

in the majority of cases of septicæmia or pyæmia, as well as the evident existence of secondary inflammations and metastatic deposits in the latter disease, proclaim the nature of the affection with no doubtful voice. It is, however, difficult at times to certify that visceral symptoms are really due to metastatic abscesses, and not to simple inflammatory lesions. Many of the symptoms of typhoid fever resemble those of septicæmia, because the intestinal lesions of the former disease lead to septic infection of the patient.

TREATMENT.—The indications of treatment are to remove the exciting causes of septic conditions by general local prophylactic measures, and to support the system until the poison is eliminated. An abundance of fresh air, sequestration of pyæmic, erysipelatous and similar patients, sterilization of clothing and instruments that possibly contain septic germs, and the aseptic or antiseptic treatment of all wounds, are important factors in preventing the occurrence of the disease in hospitals. These are general measures to preclude the advent of the disease among patients with operative or accidental wounds who are to be subjected to the influences of hospital wards. It is especially necessary, moreover, so to treat every patient that he may not be liable to self-infection from generation of the septic poison in the discharges of his own wound. Hence, union by first intention, or by rapid and healthy granulation, is to be obtained as quickly as possible. The surgeon must be on his guard, however, lest in this endeavor he allow purulent accumulations and burrowing to occur; for pus contained in irregular cavities exposed to the air soon decomposes, and putridity is the fertile source of septic infection. Hence, free incisions, counter-openings, and perfect drainage of the lowest depths of the wound, with copious antiseptic affusions, are absolutely essential. Free laying open of irregular, lacerated, and dirty wounds, even before suppuration occurs, especially if serous cavities be involved, is often the most scientific treatment, although, to the inexperienced mind, it seems like protracting the cure by increasing the wound surfaces. Such wounds should be thoroughly washed out with sublimate solution (1 : 500 to 1 : 5000), carbolized water (1 : 40), solutions of chloride of zinc (1 : 100 or 1 : 50), or some similar antiseptic lotion, before suturing or dressing. In very large wounds corrosive sublimate may cause toxic symptoms if used in strong solution. Shreds of devitilized tissue, decomposing blood-clots, and unhealthy pus confined in any portion of such wound will cause septic or pyæmic symptoms with great readiness. All abscesses forming in the neighborhood of the original wound must be opened promptly. The method of dressing wounds must be that known as the aseptic or antiseptic method, of which there are many variations fulfilling the same conditions. Mopping the surface with undiluted carbolic acid may, perhaps, become an important preventive agent in certain cases, where infection is feared, as it probably seals the vessels and hinders septic absorption.

To support the system after septic infection has occurred, tonics, stimulants, and nutritious food must be employed. There is no specific remedy available. At first a laxative may or may not be required. The appearance of the tongue and state of the bowels indicate or contra-indicate its use. Quinia (gr. ij) and tincture of chloride of iron (♏ xx) every three or four hours; brandy in amounts varying from two to six fluidounces daily, and opium, if pain demands it, in one or two-grain doses every second or fourth hour, will be the line of medication suited to the majority of cases. Frequent administration of cream, milk, and animal

broths, given in small amounts, day and night, is absolutely essential. An astringent combined with opium (as for example, tannic acid gr. ij, opium gr. j, capsicum gr. $\frac{1}{4}$); atropia sulphate gr. $\frac{1}{60}$; turpentine ♏ x, or some other remedy, may be needed at varying intervals, to combat diarrhœa, profuse sweating, or dry tongue and tympanites. In fact, symptoms must be met by appropriate remedies, since no specific to eliminate the poison is of recognized value, though many have been advocated.

CHAPTER IV.

SCROFULA AND TUBERCULOSIS.

Definition.—Scrofula, or struma, was formerly believed to be a constitutional condition in which there existed an abnormal tendency to inflammations of unusual chronicity, and in which the inflammatory products were not readily absorbed, but infiltrated the tissues and underwent cheesy degeneration. These inflammations occurred either idiopathically or after slight injuries, and were especially prone to attack the lymphatic glands, the skin and mucous membranes, the serous membranes, and the bones and joints.

We now know that scrofula is simply tuberculosis, usually of the infiltrated and not of the nodular form; and that it is due to the bacillus tuberculosis. The structures mentioned above are obviously those into which the parasitic plant most readily penetrates. Microscopical examination of scrofulous lesions shows the presence of typical tubercles and the bacillus. It is a well-known clinical fact that miliary tubercles may result from scrofulous lesions. Lupus, also, is probably simply an example of cutaneous tuberculosis. It is thus seen that these three conditions, which formerly were considered separate diseases, are now, according to recent pathological research, included in one category.

Tuberculosis is an infective disease due to a bacillus. Its lesions may be so numerous as to justify the term general tuberculosis, or there may be a single lesion, when it is known as local tuberculosis. The original infection, of course, is usually a single lesion, but it is often the focus from which further infection originates, causing lesions in distant parts of the body.

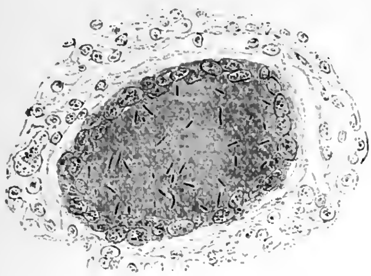
Chronic inflammation due to the bacillus tuberculosis may give rise to small nodular masses, or may assume the infiltrating form. The inflammatory lesions due to the antagonism of the tissue to the microbic irritation, are small masses of granulation tissue called tubercles, because they usually make small shot-like protuberances. Tubercles are described from their color as gray and yellow; the latter, however, are simply a later stage of the former, because the gray tubercles usually finally undergo cheesy degeneration.

Tubercles are found in the skin, the subcutaneous tissues, the mucous membranes, the serous membranes, the cancellated structure of bones, the lymphatic glands, the lungs, the liver and testicles; in fact, in almost every structure, though most frequently in those just mentioned.

Pathology.—Gray or miliary tubercles are, according to my conception of prevalent pathological views, minute inflammatory shot-like tumors or growths, not larger than a millet-seed, consisting of granulation tissue and resulting from infection of the system by the bacillus tuberculosis. The general infection occurs through the blood and lymphatic currents, and is due to the transfer of the organisms from some local tubercular inflammation which may have remained many months without infecting the rest of the body. The gray tubercles undergo

cheesy degeneration, as, indeed, may any structures which have little vascularity and great abundance of cells, and become yellow tubercles. Miliary tubercles may not only be due to some previously existing caseous tubercular centre, but become caseous themselves. The term yellow tubercle is often applied to cheesy masses, without much reference to their causation. Gray tubercles show microscopically a network of large, branched, many-nucleated cells, called giant-cells, associated with a small-celled structure resembling adenoid tissue. Differences occur, however, with variation in locality of the tuberculous lesions. The bacilli are found within the tubercle, and especially in the giant-cells. Persons who may have an inherited proneness to inflammatory affections, characterized by chronicity and by products containing many cells and tending to caseation, would be most liable to afford a suitable soil for the tubercle bacillus, and thus become tuberculous. They are those who were formerly called scrofulous or strumous. Cheesy or calcareous degeneration, encapsulation of the bacilli by fibroid or scar tissue, and breaking down into puriform fluid, causing the so-called chronic abscess, may occur as secondary changes.

Fig. 7.



Tubercle bacilli in giant-cell. Specimen from tuberculosis in a horse. (Green.)

Causes.—It was formerly taught that the tendency to such inflammations was often inherited, constituting hereditary scrofula, but that a chronic inflammation might cause infection and tuberculosis in one who had not previously shown any caseous degenerative changes, and who had no inherited predisposition thereto. This was denominated acquired scrofula. A chief cause of inherited scrofula was thought to be syphilitic ancestry, which established the tendency to chronic and cellular forms of inflammation. The acquired tendency to scrofulous affections was attributed to improper nutrition, often, perhaps, due to feeding infants on the milk of tuberculous cows, to impure air, exposure, and overwork. We now know that it is infection by a vegetable parasite which causes these anomalies, and that the fungus produces its effects most surely when it finds a suitable soil for its germination. Such a soil is furnished by the ill-nourished, the weak, whose tissues prove least resistant to mycotic invasion. Scrofula and tuberculosis exist much more frequently among children and young adults, but no age is exempt from such affections.

Symptoms.—The affections which are apt to occur among those called tuberculous are characterized by protracted inflammation and degeneration of the tissue, often giving rise to a puriform liquid. The products of this chronic inflammation, instead of being rapidly absorbed, accumulate and often become cheesy. Enlarged lymphatic glands, which may degenerate into caseous masses, or soften and give rise to thin curdy puriform fluid, are frequent. Other lesions are chronic catarrh of the various mucous membranes; cold abscesses which burrow, and, discharging, leave ulcers with livid, ragged edges, that in turn are followed by irregular and puckered cicatrices; phthisis, synovitis, and arthritis; caries and necrosis; corneitis; and ulcers and cutaneous inflammations, often called scrofulides.

Attempts to define the physical and mental characteristics of those liable to suffer from strumous disease are valueless, because all temperaments may, as we now know, become tuberculous from infection with the bacillus tuberculosis.

Treatment.—Inherited predispositions to tubercular infection must be so treated as to prevent the possibility of infection; when infection has occurred the original lesion must be so managed as to obviate general infection. The best possible condition of nutrition must be obtained by good diet, warm clothing, and out-of-door life in equable climates, combined with bathing and friction of the skin. The digestion must be carefully watched, and regulated by alkalies, laxatives, mineral acids, tonics, and proper exercise. Each case demands especial study. Cod-liver oil, syrup of iodide of iron, quinia, iodide of potassium, iodoform, iodine, arsenic, mercury, chlorate of potassium, and rarely alcohol, are the medicinal agents usually required, but they are secondary to the hygienic measures mentioned. To hasten the cure of the chronic inflammations, local measures, such as recommended under that heading, are required. Early and complete excision of the tubercular lesion is often the safest course. The pus of abscesses is sometimes absorbed, but it is better to evacuate it with a knife or aspirator than to have the deformed cicatrix due to spontaneous evacuation. Glandular masses, if small, may be enucleated. To avert an impending scrofulous or tuberculous general infection, excision of bone, arthrectomy of a joint, or even amputation of a limb, may be necessary. Such operations, however, must not be done too hastily, though in certain cases their expediency is unquestioned as a factor in preventing or ameliorating an acquired tubercular habit. The deformity due to irregular cicatrices after abscess of cervical glands may be relieved by dissecting out the elevated masses, and by sliding skin over the depressed scars so as to make a level surface with a single white linear scar.

CHAPTER V.

SYPHILIS.

Definition.—Syphilis is a constitutional disease resulting from a blood poison, of unknown nature, introduced by inoculation or by hereditary transmission. The acquired form has a period of incubation, and appears to be self-protective—that is, a person who has once been inoculated is not liable to be affected by subsequent exposure to the virus. The words venereal disease are often used to include syphilis, chancroid disease (improperly called local syphilis), and urethritis. The term should be rejected because these affections are by no means always acquired through sexual intercourse, and are so mutually distinct that any classification of them under one heading induces mistaken ideas of pathology.

While discussing syphilis and its primary lesion, hard chancre, I shall speak incidentally of chancroid disease, or soft chancre, which is a distinct affection, resembling the first manifestation of syphilis, but not resulting from constitutional infection. This disease, as well as urethritis, or gonorrhœa, will be fully considered under local diseases of the genito-urinary apparatus, where they properly belong; though chancroid is by some described in this connection because of its important differential diagnosis from syphilis.

Causes.—Syphilis, when not congenital, can only be produced in healthy individuals by inoculation with the specific virus. Inoculation may occur directly, from contact usually, of an abraded surface, with the secretions of primary or secondary manifestations of the disease situated upon another person, or indirectly by the discharges of such lesions being transferred by means of drinking-cups, surgical or dental instruments, tobacco-pipes, towels, etc. In the vast majority of cases of acquired syphilis, inoculation occurs during sexual intercourse, from chancres or mucous patches upon the genitals. Inoculation may occur from the blood of syphilitics, taken during the eruptive period of the disease, being introduced into the system by vaccination, skin-grafting, and, perhaps, also by contact with the menstrual blood of women infected with constitutional syphilis, who have at the time of coitus no lesion of the genital organs. It is doubtful whether the saliva, milk, and semen can cause syphilis, unless mixed with the discharges and blood coming from mucous patches or other lesions. The discharge from tertiary ulcers or gummy tumors is not capable of inoculating other persons. It is not absolutely necessary that a break or abrasion of the skin or mucous membrane exist to permit admission of the virus. A woman, previously healthy, may, it is said, become infected from carrying a fœtus which is syphilitic from the semen being furnished by a syphilitic father. The woman, if this is true, is infected by the man, not directly, but secondarily through the medium of the fœtus and the placenta.

A prolific cause of syphilis is heredity. Two syphilitic parents are almost certain to have, if repeated abortions do not interfere, children who subsequently exhibit symptoms of constitutional syphilis. If only

one parent is syphilitic the child is less liable to infection, particularly if the diseased parent is the father. Hence marriage of syphilized subjects is to be discouraged; though if the acquired disease was mild and well treated and no lesions have appeared for one or two years, the risk of contaminating the wife or husband and of producing children with syphilitic constitutions is reduced to a minimum. Scrofulous or tuberculous children are frequent witnesses of such marriages which have not in truth produced true hereditary syphilis; but have brought forth a posterity liable to chronic inflammations, caseation, and tubercle infection.

The cause of syphilis is almost certainly a microörganism, though up to this time it has not been definitely and certainly found.

Clinical History.—A study of the symptoms of syphilis reveals the existence of:

1. *A stage of incubation* lasting two or three weeks, followed by

2. *A primary stage*, marked by chancre and bubo, which, at the end of two or three months, is followed by

3. *A secondary stage*, characterized by eruptions and inflammations of the mucous membranes, which, at the end of six or twelve months or a longer period, is succeeded by

4. *A tertiary stage*, exhibiting itself by ulcers and other severe cutaneous lesions, bone diseases and gummy deposits, and which often is followed, if the patient marries, by what may be called

5. *A quarternary stage*, exhibited in his children. The quarternary form, or hereditary syphilis, presents lesions similar to the secondary and tertiary stages of acquired syphilis.

Symptoms.—*The stage of incubation* is the period between the time of contact with the virus and the appearance of chancre. It varies greatly, but lasts, on the average, two or three weeks. It often is represented by the patient to be longer than this, because he fails to recognize the advent of a small chancre

During any portion of the incubation period local inflammation of the parts may arise, due to simultaneous contact with irritating discharges (chancroid, etc.), or to injury, which has no pathological relation to the syphilitic chancre that is subsequently developed. The local disease may persist even after the stage of incubation has passed and the initial lesion (chancre) is exhibited.

If the syphilitic inoculation was effected at the same point at which the inflammatory ulceration, due to irritating discharges, is in progress, the patient will have the two lesions combined at that locality. This fact has induced many observers to believe erroneously that chancroid may be followed by syphilis.

Primary stage.—The initial lesion of acquired syphilis is always chancre, which is soon followed by lymphatic involvement, causing adenitis. The inflamed and enlarged glands constitute a swelling or tumor, called bubo. It must be remembered that when chancre appears the patient has already been syphilitic for two or three weeks; that is, during the time of the incubation stage. The chancre is the result of his syphilitic condition, and is not a local sore, which generates the poison that infects the system. The chancre, which must not be confounded with the chancroid sore (chancroid, soft chancre, non-infecting chancre), presents different appearances, according to its situation and the depth of the tissue involvement. Very frequently it is a small, superficial papule, having a reddish color and a circularly or eliptically ulcerated apex. Sometimes there is no ulcer whatever, but it is rare that some ulceration does not appear. It is

probable that the ulceration is usually due to infection of the surface of the syphilitic lesion by pus bacteria. Abrasion, perhaps, removes the epidermis from the papule, and pyogenic organisms infect the part so that suppuration and ulceration occur. When the ulcer exists it is not much excavated, and secretes a serous fluid, containing epithelial and other particles, but no pus, unless active inflammatory processes have been developed by irritation. The papule, with or without ulceration, has at its base a thin layer of hardened tissue, which is sharply defined, and resembles to the touch a disk of cartilage or parchment, buried under the skin. This induration is less apparent when the chancre is located on a mucous than when on a cutaneous surface, and in some cases does not persist long. At other times the chancre is a deep ulcer, with elevated edges and a surface covered with a sloughing material; still the discharge is not purulent, but watery and, perhaps, slightly sanguinalent. The induration is deep and slightly outlined, and gives the sensation of a split pea between the finger-tips. This hardening lasts a long time even after the ulcer has been healed; but, finally, when cicatrization and absorption have occurred, there remains a cicatrix with comparatively little depression. The ulceration does not destroy the tissue of the part as much as it appears to do, since it is the newly-formed inflammatory lymph that disintegrates.

Both these forms are true chancres, but the deep ulcer seems to be due to a more virulent infection, as it appears sooner after inoculation than the superficial chancre, and, as a rule, does not follow inoculation from secondary syphilis, which is more apt to cause superficial chancre, such as described above. Either form of chancre may assume phagedenic action under local irritation, or on account of a depressed state of the system of the patient, such as struma and scurvy.

The secretions from these indurated, hard, or infecting chancres, whether superficial or deep, will not produce similar sores when applied to other parts of the patient's body, for he is protected against further syphilitic inoculation. How long this protection lasts is not definitely understood. On this account chancre is single, unless inoculation at several points has occurred at the same time.

Coincident with the stage of induration of chancre, enlargement and induration of the nearest lymphatic glands appear, constituting the syphilitic bubo. These bubos are usually situated in the groin, because the common location of the chancre is upon the genitals. Bubos, however, are found in the axilla, above the internal condyle of the humerus, under the jaw and elsewhere, according to the position of the chancre. If the initial lesion is near the middle line, a bubo will, probably, be found on both sides. If the lymphatic vessels from the inoculated spot lead to internal lymphatic glands, as in uterine chancre, no external bubo will be manifested. Induration of the glands is, probably, always present in syphilis, but cannot occur unless chancre has preceded it. Syphilitic bubo appears, about three weeks after inoculation, as a chain of hardened and enlarged glands, which are painless, or nearly so, and show no tendency to suppuration. The inflammation affects the glands only, and not the surrounding tissue, hence they retain their characteristic almond shape, and do not suppurate unless there be some cause of pyogenic infection, such as co-existing chancroid disease, or an infected wound. Then the suppuration is not syphilitic, though, if due to chancroid, the pus may have the contagious properties of that *non*-syphilitic sore. If it be due to other inflammatory causes, the pus is as innocent as the pus from common acute

abscesses, or ordinary so-called sympathetic suppurating buboes; that is, it contains pus organisms, but not the syphilitic poison.

The chronic and indurated bubo of syphilis may continue for many months after the chancre has disappeared. The clinical history of true syphilitic bubo is very different, as will hereafter be seen, from that of bubo following chancroid disease.

Secondary stage.—About six weeks after the appearance of the chancre, the patient becomes more or less feverish, has, perhaps, headache and general uneasiness of an indefinite character, and then discovers, in the course of five or six days, the existence of an eruption, sore-throat, mucous patches, cervical adenitis, falling of the hair, or iritis. These are the symptoms of the secondary stage, which usually occurs at the time mentioned, and is preceded by the prodromes described. It may be delayed until the sixth month, and often overlaps the period of primary syphilis, which is prolonged by imperfect resolution of the chancre and bubo.

The cutaneous lesions of syphilis are called syphilides or syphiloderms, whether occurring as symptoms of the secondary or tertiary stages. In secondary syphilis, the eruption is usually macular or papular in form; though the scaly, vesicular, pustular and tubercular syphiloderms may occur. The last two varieties are more common in the later periods of secondary syphilis, or in the tertiary stage. Syphilitic skin affections usually become somewhat brownish in color about the time of their disappearance, are accompanied by very little itching, often present several varieties at the same time, and are not confined to a single portion of the patient's body. Mucous tubercles or patches are flattened and elongated elevations, a quarter or half an inch in diameter, found on the mucous surfaces, at the muco-cutaneous junctions or where the skin is very delicate, and covered by a whitish exudate. They appear at first as reddish elevations, from which the cuticule is removed, and upon which the exudate soon occurs, giving the surface an appearance similar to that produced by touching mucous membrane with nitrate of silver. The sore mouth and throat of secondary syphilis are due to these mucous patches, to superficial inflammation and ulceration, or to a combination of these lesions.

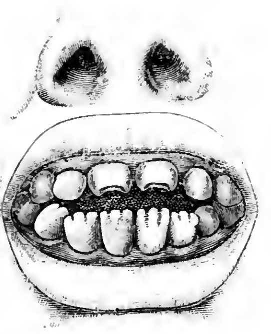
Inoculation of syphilis occurs more frequently from these mucous patches about the genitals and mouth than from the secretions of chancre itself. Inflammation and chronic enlargement of the lymphatic glands, especially of those situated along the posterior margin of the sterno-mastoid muscle, are very frequent symptoms of the secondary stage. These have no necessary relation to the existence of marked cutaneous lesions in the neighborhood. Falling of the hair of the scalp and other regions, and inflammation of the iris are frequently present in secondary syphilis. The papular eruption often occurs as an accompaniment of the iritis. Other symptoms may present themselves in the secondary stage, but the most common have been mentioned.

Tertiary stage.—There is no distinct separation between the secondary and tertiary stages, but the latter is characterized by more chronic and less contagious lesions, which affect, as a rule, the deeper tissues of the body. It is convenient to consider lesions originating after the lapse of six months as tertiary symptoms. Tertiary symptoms are not exhibited in all cases, because the disease may be so mild or so judiciously treated that it subsides or becomes latent with the disappearance of the secondary troubles. Very often, however, the disease remains in abeyance for many months or years, and then tertiary lesions supervene.

The lesions produced by tertiary syphilis may be classified under the

following heads: 1, Fibroid degenerations; 2, gummy deposits; 3, changes in the arterial walls. The fibroid indurations occur in limited areas surrounded by normal tissue, and are found in periosteum, sheaths of nerves and of organs, and in muscle. Gummy tumors or deposits are yellowish masses of firm consistence, due to degenerated cell-products, surrounded by a fibrous area, which is in turn encircled by a cellular and vascular zone intimately adherent to adjacent structures. They are the most characteristic formation of syphilis and occur in the tegumentary structures, muscles, fasciæ, bones, and internal organs. They may become caseous, but often in a manner not well understood, cause suppuration around themselves, break down and cause the deep intractable ulcers of tertiary syphilis. The change in arterial walls occurs in the inner coat and causes diminution in calibre, which interferes with circulation and may induce degenerative changes. The tertiary syphiloderms are usually pustular, tubercular or ulcerous. The ulcerations and suppurations found in syphilis are probably the result of the low vitality of the cells, affording a place of least resistance for the harmful localization of pyogenic fungi circulating in the blood-stream. The germs cause suppuration there, when to healthy tissues they would be unable to do injury. The rupial ulcer with its acuminated scab is especially characteristic, as are the deep ulcers due to destructive changes in gummy tumors. Similar lesions of the oral and other mucous membranes are frequent. Periostitis, osteitis, nodes due to lymph or gummy deposits under the periosteum, and all causing bone-pains (osteocopic pains) especially at night; caries and necrosis; iritis, retinitis and choroiditis; falling of the hair; onyxitis; orchitis; cerebral and spinal inflammations; and, in fact, inflammation of any organ or tissue may be induced by constitutional syphilis. Many of these lesions depend on the deposition of gummy material, others are due to the fibroid and arterial changes mentioned.

Fig. 8.



Notched teeth of hereditary syphilis. Boy, ten years, who had periostitis of tibia. Lower teeth show normal serrations of second dentition, and are elongated, probably because the imperfect upper teeth do not oppose them.

Fig. 9.

Upper incisors of boy with symptoms of inherited syphilis from infancy. Typical notches.

Quarternary stage.—This seems to me a good name to apply to hereditary syphilis, though I admit that syphilitic children may be born to parents who have not yet advanced beyond the secondary stage. It is unnecessary to discuss the method by which children inherit the syphilitic cachexia, but it is recognized that the disease is more certainly derived from a syphilitic mother than from a syphilitic father, and from two more certainly than from one syphilitic parent.

The child may not present any distinctive symptoms until a few weeks after birth, when its unhealthy looking and shrivelled skin, its aged

appearance, the nasal catarrh and stomatitis due to the inflamed mucous membranes, and the possible discovery of cutaneous eruptions or of mucous patches about the anus and genitals will point unequivocally to its syphilitic parentage. The syphilis so exhibited is of the secondary form; and by its ability to inoculate other subjects, and its greater or less protective power against further inoculation of the same subject, it proves its identity with ordinary acquired syphilis.

If death does not remove the child, further secondary and tertiary symptoms will in time follow. Interstitial keratitis, periostitis, bone disease, and many tubercular affections will in time be developed. The low cell-vitality of syphilitic children makes easy the assaults of the tubercle bacillus. The resistance of healthy tissues is wanting. The peculiar notched condition of the upper central incisor teeth of the permanent set, first described by Hutchinson, of London, is often seen.

These two teeth, and at times others, are poorly developed; having a conical shape and a cutting edge, which is marred by an irregularly bevelled anterior surface, or even distinctly notched by the breaking away of the central portion. This notched condition must not be confounded with the normal serrated edge of newly extruded teeth of healthy children. The teeth of syphilitic children are often irregularly placed, and look like the end of a screw-driver or are mere pointed pegs. Syphilitic women are liable to abort frequently because of the diseased condition of the placenta, and it is only after the woman has regained a fair degree of health that the fœtus is carried until full term.

Diagnosis.—The diagnosis of syphilis rests upon the general clinical history of the disease rather than upon any one symptom or upon the statements of the patient. The distinction between chancre and the local affection called chancroid disease is often difficult, and at times impossible, unless time be given to watch the progress of the symptoms. The diagnosis is to be founded upon the following characteristics:

Chancre.	*Chancroid.*
Time.—No noticeable lesion until two or three weeks after exposure.	Irritation early and sore developed within a week after exposure.
Number.—Single unless several points inoculated at time of exposure.	Multiple, because pus is auto-inoculable and produces other ulcers.
Character.—Papule, superficial abrasion, or an elevated ulcer, with edges sloping towards center, which coalesces with adjacent tissue and discharges a scanty, serous, non-purulent fluid. Permanent, indolent, non-inflammatory induration at base of sore, feeling like a disk of parchment or a split pea beneath the integument. No tendency to phagedæna. Heals spontaneously.	Ulcer, with edges steep as if a piece of tissue had been punched out or ragged and irregular; does not coalesce with adjacent tissue and is covered with a drab-colored deposit. The secretion is purulent, very copious, and inoculates surrounding surfaces, thus producing multiple chancroids. No induration. Liable to phagedæna. No tendency to heal.
Bubo.—Always present, involves a chain of glands, is indurated, usually bilateral, and seldom suppurates. If it does suppurate pus is not inoculable.	Often absent, involves but one gland and one side. Very prone to suppuration, furnishing pus which readily inoculates and produces other chancroid ulcers. The suppurating bubo is practically a chancroid.
Pathological nature.—Due to a constitutional disease, which is soon manifested by other symptoms. Protects the patient from subsequent inoculation; hence, surgeon cannot produce another chancre on him by inoculation with the discharge from the suspicious sore.	A local affection never followed by constitutional symptoms and, therefore, does not protect against subsequent inoculation: hence, surgeon can produce many other chancroids by inoculating patient with pus from original sore.

This table gives the usual clinical history of the two affections, but it must be remembered that the time of appearance and the physical char-

acteristics may vary somewhat. Thus, a chancre may be so infected by pus fungi as to furnish a purulent secretion; and a chancroid may have a slightly indurated base by reason of repeated applications of caustics.

Chancre is to be distinguished from epithelioma by the earlier glandular involvement it causes, the effect of anti-syphilitic treatment, and the concomitant constitutional symptoms. Many doubtful cases of cancer and of chancroid can be diagnosticated by the collateral evidence obtained from confrontation of the patient and the person by whom he is supposed to have been inoculated.

Secondary and tertiary syphilitic lesions are to be differentiated from non-specific affections by the history, the co-existence of multiple pathological changes, the exclusion of other causative factors and the response to anti-syphilitic remedies.

Treatment.—Syphilis is a constitutional disease and demands general treatment. Cauterization or excision of the chancre is valueless, since constitutional symptoms are not the result of the chancre, but the latter is a lesion due to general infection dating from the time of inoculation. Hence, the local treatment of chancre should consist of measures that prevent the irritation of the ulcer, such as is caused by rubbing against the clothing and infection with pyogenic microbes. Antiseptic protection of the primary induration before the epithelium is abraded is eminently proper. Cleansing with soap and water and a dry dressing of sublimate gauze, so applied as to permit urination, is judicious treatment. Iodoform dissolved in collodion (gr. x to f℥j) is a convenient application, as it makes an impervious coating. It should not be applied until the sore is made aseptic by washing with soap or sublimate solution. If the chancre becomes phagedænic, which is rarely the case, strong caustics, such as undiluted nitric or carbolic acid or nitrate of mercury, may be employed to arrest the destructive action. The actual cautery destroys the microörganisms better than any of these. It must be applied to every crevice of the sore. Bubo, as a rule, demands no local treatment, for it is painless and merely an expression of the constitutional implication. Moreover local treatment is useless because it, as a rule, effects no result. If suppuration occurs about the indurated glands, the pus should be evacuated as if the abscess were non-specific, which, indeed, it really is.

The special constitutional remedies for syphilis in all its stages are mercury and iodine; of these mercury is probably the more important and efficient. The manner of using these drugs is important, but the preparation employed may vary with the fancy of the surgeon and the convenience of the patient. It is absolutely essential that the effect of the remedy be maintained for one or two years, if the tendency to secondary and tertiary manifestations is to be eradicated. Mercury is the better remedy for the primary and secondary lesions, and iodine probably the better one for the tertiary affections; though this dictum may at times be invalidated by individual experience. In the later lesions I usually employ a combination of both drugs.

As soon as the diagnosis of syphilis is established, mercurial treatment is to be instituted, and, even in doubtful cases, I should probably give the patient anti-syphilitic remedies. Many, perhaps most, syphilographers prefer to wait until the diagnosis of a doubtful sore is absolutely established by the occurrence of secondary symptoms. The green iodide of mercury (often called the protiodide) may be given in quarter-grain pills three times daily after meals; or a corresponding amount of blue pill or calomel may be substituted. If it is found in the course of a few days

that unusual looseness of the bowels is produced, one or two grains of tannic acid or a sixth of a grain of opium may be added to each pill. This amount of mercury will probably be tolerated for several weeks without causing tenderness of the gums or undue salivary excitation. As soon as either of these effects is induced the amount must be decreased or the drug entirely suspended for a week. In cases where the disease is violent in its first manifestations, an early decided mercurial impression is necessary. Blue pill in one to three grains daily, or calomel to the amount of one-half to two grains daily, or a similar amount of green iodide continued until evidences of moderate constitutional effects become evident, is judicious treatment. If no beneficial effect is observed from ordinary small doses, and the condition of the gums will warrant it, the dose must be increased. In this tentative manner the maximum quantity which the patient can take without causing gastric, intestinal, or oral irritability is determined. This he must continue during nearly two years, occasionally omitting treatment for one or two weeks, but never suspending it entirely, even if no further constitutional symptoms have shown themselves. There is no danger of taking these small or tonic doses of mercury for too long a period in this way, but there is often a tendency to tire of what seems unnecessary tediousness of treatment.

If it is preferred, some of the other mercurial preparations may be used, or the agent may be introduced into the system by inunction, fumigation, hypodermic injection, or suppository.

For inunction thirty or forty grains of the officinal ointment of mercury may be rubbed into the thin skin of the inner side of the arms or thighs at bedtime. Fumigation is accomplished by volatilizing a half drachm of calomel by means of a lamp placed under a metal plate upon which the drug is spread. Any apparatus which will allow this arrangement, and at the same time furnish an atmosphere warmed and filled with steam, is all that is required. The patient is divested of clothing, and surrounded by a rubber cloth extending from his neck to the floor. Under this covering the generator of mercurial vapor and of steam is placed, and thus the moistened cutaneous surface is subjected to the remedial influence.

Such fumigation may be repeated every day for fifteen minutes, and is especially available in syphilitic skin affections. Internal treatment may be used in conjunction with these mercurial baths. The corrosive chloride of mercury in doses of from one-thirtieth to one-tenth of a grain may be given hypodermically. All these methods, however, are too inconvenient for prolonged use, and will never supersede the ordinary mode of administration, except in especially selected cases. At certain times, because of the inefficiency or undesirability of mercury, the preparations of iodine must be utilized. The iodides of potassium, sodium, and ammonium are usually adopted because of their cheapness, convenience, and efficiency. Iodoform is too offensive in odor, and many other preparations are too expensive or bulky. The iodides seem more valuable in the late lesions of syphilis than in the primary and early secondary affections. They are to be given in ten to thirty grain doses three or four times daily, after meals, and preferably, perhaps, in alkaline solutions. The sodium iodide will often produce less coryza and mucous irritability than the commonly employed potassium salt, though the remedial power of the drugs is about equal. Upon some persons the iodides act as a poison, and in very small doses produce coryza, conjunctivitis, cough, and a papular eruption. Usually, however, these disagreeable effects can be

obviated by combining a small amount of morphia with each dose, or by resorting to some other preparation of iodine.

Before leaving the constitutional treatment of syphilis, it is necessary to remind the reader that many patients are so broken down by the effects of the syphilitic poison, or by previous conditions of ill health, either acquired or hereditary, that the use of corroborant remedies is imperatively demanded. Such cases require quinia, iron, mineral acids, stimulants, cod-liver oil, and concentrated food. It is often possible to keep up this line of action while administering the small doses of mercury, or the iodides. If these remedies seem to interfere with digestion and produce anæmia, they must be suspended or reduced in amount for a time, and the reliance of the surgeon be upon the tonic and supporting regimen. It is a mistake, however, always to consider the prolonged course of mild specific medication a depressing agency, for in the majority of cases it is the syphilis that depresses, and the specifics which neutralize this poison are really the proper drugs to increase the health equation. Agents which tend to eliminate morbid matters from the blood are doubtless valuable; hence, Turkish baths and secretory stimulants probably are beneficial in the treatment of syphilis.

Again, it is very often of advantage to combine the mercurial and iodine treatment when either agent alone does not beget favorable results. In very late lesions, unusually large doses of iodide of potassium, such as a half drachm or a drachm, largely diluted and taken after food three or four times daily, will occasionally work astonishing cures of painful conditions due to periostitis and nerve lesions. I usually give about thirty grains of the potassium iodide before each meal, and a half to one grain of the green iodide of mercury with a grain of tannic acid after each meal. These remedies should not be taken at the same time, as red iodide of mercury might perhaps be formed and poison the patient.

Hereditary syphilis must be treated with mercury and iodine, combined with or occasionally replaced by tonics, in the same manner as acquired syphilis. The syrup of iodide of iron in twenty or thirty drop doses is often an eligible preparation. Warm clothing, good diet, and hygienic surroundings of the best character are important factors in bringing syphilitic children to adult life. It is probable that the subjects of inherited syphilis are more or less protected against inoculation with syphilitic virus.

Any incidental symptoms that occur during the progress of either acquired or hereditary syphilis must be managed on general principles. Thus, impaired digestion, constipation, fever, sleeplessness, and such conditions, may require laxatives, astringents, refrigerants, or hypnotics.

The local treatment of syphilitic lesions is important, but far less so than the general treatment, except in the case of iritis. In iritis it is absolutely essential to drop immediately into the eye a strong solution of atropia (about four grains of atropia sulphate to the fluidounce of water); because, if this is delayed, the iris will become glued to the anterior capsule of the lens, and the permanently contracted pupil be occluded by the deposit of inflammatory lymph. Hence, wide dilatation of the pupil must be obtained at once, after which, or indeed during the same time, constitutional remedies are administered.

Mucous patches and ulcerations should be touched with fused silver nitrate or a solution of nitrate of mercury (1 : 10). Cutaneous ulcers will heal more rapidly if slightly stimulated with diluted ointment of nitrate of mercury (1 : 10), or with some astringent, such as copper sul-

phate, silver nitrate, nitrates of mercury, iodoform, or chloral. The various remedial measures described under ulcers are applicable.

The falling of the hair, technically called alopecia, may require stimulating applications to the scalp, such as alcohol, ointment of the nitrate of mercury, tincture of cantharides, tannic acid, and ammonia, suitably diluted.

Lymphatic glandular involvement may be benefited at times by pressure, absorbent plasters and lotions, and by interstitial injections of alcohol or iodine.

Periostitis, which often causes excruciating pain, may be relieved by blisters, or by subcutaneous incision of the periosteum, which relieves tension.

Other operations may, at times, be required for the removal of diseased bone or irrevocably degenerated members.

CHAPTER VI.

RICKETS OR RACHITIS.

Definition.—Rickets is a diathetic affection, and, therefore, should not be described under disease of bone, but in the present connection. Its characteristic is an abnormal deposition of cartilaginous material, with incomplete ossification. The effects of this constitutional condition are shown in softening and distortion of bones, and in changes resembling amyloid degeneration in the liver, spleen and other organs.

Pathology.—Rickets seems to depend upon malnutrition, which causes deposition of abnormally large areas of soft, cartilaginous tissue which cannot be at once perfectly ossified by calcific transformation. Hence the bone is thickened by soft, subperiosteal, cartilaginous deposits, which do not add to its strength, because the medullary cavity is simultaneously increasing. The bones are, therefore, easily bent out of shape. The epiphyseal cartilages, in a similar way, are enlarged, and, becoming imperfectly ossified, allow deformity in the vicinity of the joints. Marked deposition is apt to occur about the edges of the cranial and other flat bones. After a time excessive deposit of bone salts occurs, and sclerosis, or abnormal hardening, of the bones takes place. The visceral changes resemble amyloid or waxy degeneration.

Causes.—The etiology of rickets is unknown. Heredity, food deficient in organic salts, and the presence of lactic acid or phosphorus in excessive amounts have been named, but not established as causative factors. Deficiency in amount of fresh food is an important factor in its production.

Symptoms.—Rickets is a disease of childhood, and appears about the second or third year of life. The premonitory symptoms are not distinctive, and no definite diagnosis can be made until the enlarged extremities of the long bones, the nodules at the junction of ribs and costal cartilages, and the bending of the bones by muscular traction and the weight of the body in walking, point out the rachitic condition. The child may be restless, sweat profusely about the head, show digestive derangement, exhibit irregularity in dentition, and complain of muscular pain upon moving or being handled. There is often no febrile movement. The liver and spleen are often enlarged, and the child listless, emaciated and somewhat sluggish in mental development. Osseous deformities of the limbs, anterior thoracic region, spine and pelvis are commonly exhibited in tuberous enlargements and curvatures. Partial or complete fracture may occur. The fontanelles close slowly, and the occipital bone may become thinned. These symptoms may abate, as if convalescence was at hand, and be followed by recurrence of symptoms. It is not usually a fatal disease, but recovery slowly supervenes, accompanied by abnormal induration of the distorted skeleton.

Treatment.—The treatment must consist of feeding with the most nutritious food, as mother's milk, cow's milk, broths, etc., and the administration of cod-liver oil (f℥ss–ij three or four times daily), syrup of iodide of iron (♏x–xxx), quinia (gr. i–ii), compound syrup of phosphates

(♏x–fʒij), or syrup of lacto-phosphate of lime (♏x–fʒj). Fresh air, bathing and frictions are valuable adjuvants.

During the stage of softening, deformity of the bones should be averted by prohibiting locomotion, and by the application of splints or plaster-of-Paris dressings. After convalescence, slight curvatures will often be corrected by muscular action during the growth of the child. If the deformity is great and permanent, osteotomy may be demanded to relieve lameness or to improve appearances.

CHAPTER VII.

TUMORS.

Definition.—A tumor, or morbid growth, is a circumscribed enlargement of living tissue, abnormal to the part and having no physiological function, which, in its growth, is independent of the adjacent structures, and which is not the result of an inflammation. It is an atypical new formation. Most cysts are not strictly tumors. Condylomata are inflammatory formations, not tumors.

Causes.—The cause of all morbid growths is abnormal activity of the cellular elements from which they originate, but the factors or primary causes inducing this morbid activity of preëxisting cells are not easily discoverable.

It is probable that the cause of tumors is local rather than general, for, although blood alterations and hereditary conditions may influence their progress, the development of such morbid growths seems to depend on peculiarities of the tissue-cells. These peculiarities may be due to inherited cellular eccentricity which readily responds to any existing cause, or to local irritation from injurious impressions or from the immigration of foreign elements coming from primary morbid growths situated at a distance. Many efforts have been made to prove the dependence of tumors, especially malignant growths, upon microörganisms, but thus far unsuccessfully. The most tenable theory for benign growths is that there has been left imbedded in the tissues a few embryonic cells, not employed in the development of the animal in the prenatal stage of existence, which, in after-life, assume activity and develop into tumors. It has been suggested that the occurrence of carcinomas is due to the normal resistance of connective tissue being reduced until epithelium, which has an active power of growth, invades it.

Pathology.—Tumors are always developed from cells which have previously existed, either at the present seat of the growth, or at some distant spot from which they have been transported to the locality occupied by the tumor. The tumor in the former case is a primary, in the latter a secondary, morbid growth. The histological structure and development of every tumor resemble, in a greater or less degree, some normal or physiological tissue—that is, all pathological formations belong to some physiological type. The resemblance is not exact, however; they are atypical. These axioms may be clearly illustrated by saying that no tumor can be formed from cloth or straw, but in its construction and growth must resemble some animal tissue. The original elements from which tumors are developed are cells of connective tissue, of epithelium, of glands, of muscle, or of nerve. The morbid growths originating from muscle- and from nerve-cells are rare, those arising from epithelial and glandular origins quite common, and those developed from a connective-tissue basis exceedingly frequent.

A tumor whose structure is similar to the part from which it originated or in which it lies, is called homologous; one which differs from the tissue that gave it birth, or in which it is situated, is termed heterologous.

These terms are somewhat relative; for example, a cartilaginous tumor growing from the larynx would be homologous, but if appearing in the testicle it would be heterologous. Heterology is especially characteristic of malignant growths because they spread into tissues different from their original site, and are even transported, by the blood and lymph currents, to distant parts of the organism, such as the internal viscera.

An important point in regard to the relation of the new growth to the adjacent tissues is the presence or absence of infiltration. If the tumor blends with the surrounding parts so that the microscope discloses tumor cells involving the muscular and cellular tissue of the neighborhood, infiltration exists and the tumor is *diffuse*. This infiltration is very common in malignant tumors, but may not be apparent to the unaided eye. A *circumscribed* growth is one which is definitely separated from the adjacent structures, which it has pushed apart during it development. It is often isolated from them by a capsule of condensed fibrous tissue. Such growths may, during their progress, become diffuse. Microscopic examination is the only test of the absence of infiltration even in growths which appear to be encapsulated.

Tumors occasionally disappear by atrophy or absorption, and at times reach a certain bulk and remain stationary; but usually they increase in size. This increase frequently occurs rapidly even though the patient is losing weight. They may undergo changes, such as fatty degeneration, calcification, pigmentary, colloid and mucoid degeneration, inflammation, ulceration, and mortification, in a manner similar to tissues not pathological in their origin. Tumors have no nerves.

The tendency which certain morbid growths have to be reproduced, either at the original site, after excision, or in other regions by infiltrating or infecting the tissues, is designated malignancy. Hence, tumors are malignant and non-malignant. Malignant tumors, as previously stated, are capable of infiltrating neighboring tissues with their cells; and by this and perhaps other means they influence such abnormal activity in the part that similar growths arise at the circumference of the original tumor. Hence, it is not unusual to see a neoplasm surrounded by a series of small nodules.

When the surgeon removes a malignant tumor he may leave tissue which has recently been infiltrated with the tumor cells, but which appears to be normal. These cells, either by their own proliferation or by influencing proliferation in the native cells of the part, cause a similar tumor to appear at the cicatrix and its vicinity. The development of secondary tumors from malignant growths may occur in another way. The lymphatic circulation through the original disease may carry cells of the tumor to the nearest lymphatic glands, where they are arrested, and, as in the former case, induce secondary growths similar to the primary. A third manner of inducing secondary tumors is a similar transference of cellular elements by means of the blood-current passing through the growth. These tumor cells are arrested by arteries or by veins in some distant capillary system, often the nearest, and, as in the lymphatic method of infection, induce secondary growths.

Thus, it is evident that malignant tumors produce others like themselves by infiltration and by lymph and blood infection. Other methods may at times, though rarely, be operative. Tumors often show a decided preference for one or other of these methods of reproduction. The secondary growths may, in the same way, act as parents and produce a progeny with characteristics similar to their own. This transference of

cellular elements explains the circumstance that malignant tumors are frequently heterologous.

It must not be forgotten, as it often is, that multiple tumors, even when malignant, may not be secondary to another, but may be synchronous or due to the same original cause.

From the description given of the processes by which reproduction of malignant growths is accomplished, it is evident that the most malignant growths would be those containing the greatest number of cells, the most juice, and the greatest abundance of lymphatic vessels and bloodvessels. The reverse of this picture would give non-malignant or benign tumors, which, as they approach the characteristics of the other group, become more or less malignant in nature. In fact, there is no absolute line drawn by nature dividing the malignant from the non-malignant; although it is admitted that tumors with one histological structure are usually malignant, and others usually benign, either class may occasionally assume the clinical nature of the other.

Classification.—Tumors are classified according to their histological structure, which, as I have previously stated, always resembles, in a greater or less degree, some physiological tissue either of adult or fœtal life. The imperfect knowledge that we possess of the development of many tissues, and the varying degrees of relative importance attached by pathologists to the microscopic elements seen in the growth, prevent a universal acceptation of a single classification. I have accepted that given by Green (*Pathology and Morbid Anatomy*), which is convenient for reference, and more familiar to the American profession, perhaps, than any other.

Classification of Tumors.

I. *Tumors whose general structure or type resembles one of the modifications of fully developed connective tissue.*

Special types:

1. Fibrous tissue.	Fibrous tumor.	Fibroma.
2. Adipose tissue.	Fatty tumor.	Lipoma.
3. Cartilage.	Cartilaginous tumor.	Chondroma.
4. Bone.	Bony tumor.	Osteoma.
5. Mucous tissue. (not mucous membrane.)	Mucous tumor.	Myxoma.
6. Lymphoid tissue.	Lymphatic tumor.	Lymphoma.

II. *Tumors whose general structure or type resembles that of one of the higher or more complex tissues than fully developed connective tissue.*

Special types:

1. Muscular tissue.	Muscular tumor.	Myoma.
2. Nervous tissue.	Nerve tumor.	Neuroma.
3. Bloodvessels.	Vascular tumor.	Angioma.
4. Lymphatic vessels.	Lymphatic vessel tumor.	Lymphangioma.

III. *Tumors whose general structure or type is that of the undeveloped connective tissue of the embryo.*

Sarcomas.

These are named according to the shape and size of the predominant constituent cell (round-cell, giant-cell, etc.); according to the character of the stroma (osteo-sarcoma, myxo-sarcoma); or according to the retrogressive changes that occur in the tumor (melano-sarcoma, calcifying sarcoma).

IV. *Tumors whose general type is that of epithelial tissue.*

1. Papillæ of skin or mucous membrane.	Papilloma.
2. Glands.	{ Adenoma. Carcinoma.

Under carcinomas, then, are:

1. Acinous carcinoma.
   a. Scirrhoma, or chronic carcinoma.
   b. Encephaloma, or acute carcinoma.
2. Epithelial carcinoma.
   a. Squamous epithelioma.
   b. Columnar-cell epithelioma; often called adenoid carcinoma.
3. Colloid carcinoma.

V. *Congenital mixed tumors or teratomata.*

Tumors due to inclusion and imperfect development of one fœtus within another, or abnormal development of a single fœtus. Dermoid cysts belong in this division.

Clinical History.—Tumors present innumerable varieties as to size, form, consistence, number, situation, and other physical characteristics. These clinical attributes have much to do with the symptoms of the growth; for example, a small tumor passing on a nerve-trunk will produce more pain than a large one in another locality; one overlying an artery will receive transmitted pulsation, another pressing upon a vein will cause mechanical dropsy. Certain tumors, especially the carcinomas, have a tendency to ulcerate and become the seat of hemorrhage.

Those growths whose clinical history is conspicuous because of their infiltration of adjacent structures, recurrence after removal, and reproduction in distant regions of the body, are called malignant. The carcinomas and many of the sarcomas usually present this feature of malignancy; the other groups, as a rule, are not malignant. There are, however, occasional exceptions, for sarcomas and even carcinomas sometimes act as non-malignant growths, while others, ordinarily benign, at times assume a decidedly malignant expression.

Causes of Death.—Death may occur from morbid growths on account of hemorrhage; asthenia due to excessive discharge; nervous irritation; mechanical interference with nutrition; asphyxia; and profound involvement of the nervous centres. Many tumors have no tendency to impair the general health. This is especially true of the non-malignant growths.

Treatment.—The treatment of tumors depends on their character. Malignant growths, and those suspected to have that character, should, as a rule, be removed by operation as early as possible. The excision should extend far beyond the apparent outlines of the tumor, because infiltration has probably taken place, though not appreciable to the eye of the surgeon. Benign growths may be allowed to remain if they neither interfere with the functions of the part nor cause indirect deterioration of health. If they show indications of probable future injurious influences they should be removed while still small, provided the excision can be done without great risk. If the tumor is more serious in its present or future aspects than the operation, operation is justifiable; but when the operation is more serious than the probable effects of the undisturbed tumor, operation is not justifiable.

In excising tumors involving deep structures and having firm attachments, the operator should endeavor at once to become master of the situation by coping at first with the most troublesome portions of the growth. It is unsurgical to spend time freeing superficial adhesions and tying vessels which will in a moment be cut again at a lower level. It is far better to work under the deeper portions of the tumor, as soon as a free cutaneous incision has been made, and thus control the primary sources of hemorrhage. This method of operating enables the surgeon

to appreciate more accurately the character of operative procedure demanded for the extirpation of the growth.

When tumors cannot be removed, relief of pain may often be obtained by open or subcutaneous division of the fascias binding them down, or by excision or stretching of nerve-trunks.

Excision of insignificant tumors is often proper because of the unsightliness produced by them, and the mental perturbation induced by their existence.

Special Tumors.

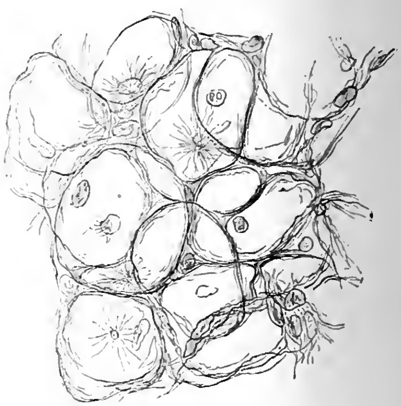
I. *Tumors whose general structure or type resembles one of the modifications of fully-developed connective tissue.*—Growths of this class are non-malignant, for when any of them, such as fibroma, enchondroma, and osteoma, occasionally assume a malignant expression, it is found on microscopic examination that they are wholly, or in part, sarcomatous. This accords with the well-known fact that a tumor may present in its different parts the structure of more than one variety of morbid growth.

Fibromas, or Fibrous Tumors.—These growths may be divided into soft and hard fibromas. The former grow somewhat rapidly, are smooth, rather soft and elastic, and often pedunculated; they are at times diffuse, though often circumscribed and encapsulated, and give rise to no pain or inconvenience except from their weight. On section they occasionally exude a large amount of serous fluid. The hard fibrous tumors are of slow growth, are smooth, very firm, usually single, generally movable unless having bony attachments, painless, and encapsulated. Fibromas, as a rule, have few vessels, but they are occasionally very

Fig. 10.

Section of fibroma, showing typical fibrous character. In this portion of tumor no cells were seen. × 220. (Holmes.)

Fig. 11.



Section of lipoma, showing nucleated oil-cells andsome crystals of margarin. × 220. (Holmes.)

vascular, and then, as the fibrous surroundings of the vessels prevent retraction and contraction, severe hemorrhage may follow their removal. Fibrous tumors originate from the fibrous tissue of the skin, connective tissue, subcutaneous and submucous tissue, periosteum, fascias, nerve-

sheaths, and other structures; and are found in many situations. They constitute one form of epulis, a variety of naso-pharyngeal polypus, and the so-called false neuroma. The last is a fibroma developed from the connective tissue in the nerve and having nerve-fibres spread over its surface. Such tumors are often multiple, and are painless. The painful subcutaneous tubercle is considered by some a fibroma which has no demonstrated connection with nerve-fibres; others think it is a true neuroma, or nerve tumor. Uterine fibroid tumors are usually myomas. Fibrous tumors may undergo softening, calcification, ulceration, and cystic degeneration.

Microscopically, fibroid tumors consist of fibrous tissue more or less compactly interlaced, associated with a few fusiform or star-like cells which are often indistinct. Rapidly developed fibromas usually present a greater proportional abundance of cells, and are soft in consistence.

Some fibromas closely approach the sarcomas in their microscopical and clinical features.

The treatment of ordinary fibrous tumors consists in non-interference, unless their bulk or situation demands removal. They are non-malignant.

Lipomas, or Fatty Tumors. — A circumscribed accumulation of adipose tissue is called a fatty tumor. They occur anywhere, though especially about the back and shoulders. I once saw one removed from the palmar aspect of the hand; I think it was in the tissues of the ball of the thumb. Such tumors are of slow growth, though they may reach a very large size; are soft, doughy, and sometimes slightly fluctuating. Often they are distinctly lobulated and frequently cause a dimpling of the integument at the situation of the fibrous septa attaching the skin to the deep fascia; they may become pendulous, and even change their position under the skin by the action of gravity; they are painless and seldom undergo degeneration, softening, or ulceration.

They consist of indistinctly nucleated cells distended with fluid fat and connected by a variable amount of connective tissue. As these cells increase in number by proliferation they are filled with fat, and thus the growth acquires bulk. The mass is usually surrounded by a capsule of condensed connective tissue. It is their localization that distinguishes fatty tumors from ordinary obesity. If lipomas require treatment they are to be removed by means of a free incision through the skin, which enables the surgeon to turn them out of the capsule with great ease. No portion of the tumor should be left behind to reproduce the growth.

Chondromas, or Cartilaginous Tumors.—These growths are found especially among young patients, and are frequently connected with the bones of the fingers. They are rarely developed from preëxisting cartilage. They occur also in glands, such as the parotid, testicle and mamma, and occasionally in the lungs. When connected with the phalanges of the hands or feet they are usually multiple, otherwise they are single. Cartilaginous tumors are smooth, hard and elastic, and often lobulated masses; of slow development, usually surrounded by a capsule, and non-malignant.

Occasionally, however, they are much softer than usual, grow rapidly, have no capsule, recur after removal, infect distant tissues by cell transferrence, and present decidedly malignant characteristics. These tumors usually show, especially at their circumference, sarcomatous structure infiltrating adjacent tissues; hence they are not to be considered true chondromas.

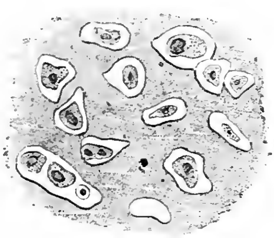
There is a form of tumor called osteo-chondroma, which consists of bone associated with cartilage and originates under the periosteum near the articular extremities of the long bones. They may become transformed into true osseous tissue.

FIG 12.

Multiple enchondroma of fingers.

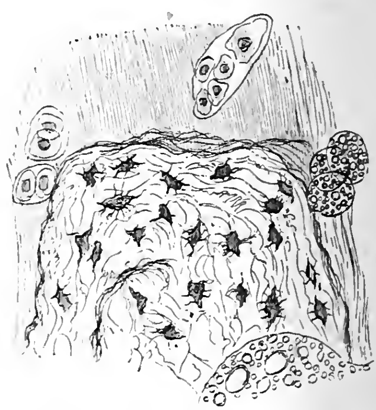
Chondromas, or enchondromas, as they are also called, are in structure almost identical with the varieties of cartilage, and yet they rarely

FIG. 13.



Hyaline enchondroma, showing cells with nuclear contents lying in a hyaline matrix. $\times$ 200. (GREEN.)

FIG. 14.



Section of an exostosis covered with a layer of cartilage. The cartilage is seen at top of figure. $\times$ 220. (HOLMES.)

originate from cartilage. They exhibit cells with nuclear and granular contents enclosed in a matrix which varies from a hyaline to a fibrous

or mucoid character. They are usually developed from the bone or from connective tissue, and not from cartilage; very occasionally they originate from costal, laryngeal, and other cartilages in the same manner as exostoses grow from bone. It has been proposed to call these overgrowths enchondroses.

Changes of a calcareous or ossific character quite often affect cartilaginous tumors. Sometimes portions soften in the interior of the growth and cause an appearance resembling cystic degeneration. If the size of enchondromas does not render them objectionable or dangerous, they may be left undisturbed. Under other circumstances excision of the growth or amputation of the affected bone is demanded. In the sarcomatous enchondromas prompt operation is probably the best treatment.

Osteomas, or Bony Tumors.—These growths, which must be distinguished from calcareous degeneration of tissue, are hard, painless, of slow development, and frequently immovable because of their firm attachment to bone. They do not acquire a great bulk, but may be multiple. Falls may cause fracture of such tumors. Inflammation of periosteum and bone will frequently give rise to osseous masses, as is seen in long-standing periostitis and when callus is formed after fractures. These are not usually regarded as true tumors, but the line between them and other bony growths is not very definite. Bony segments are occasionally formed in fibroid and cartilaginous tumors, because of ossific degeneration; and at times we have sarcomas associated with bony masses. These last may show signs of malignancy, and hence must be distinguished from true osteomas, which are benign. Irregular masses of spongy bone are often ossified chondromas.

On section osteomas resemble bone, showing lacunæ, Haversian canals, and canaliculi. Some consist of cancellated or spongy bone surrounded by a thin layer of compact bony tissue, others are much more compact; while still others are so dense that they show no spongy structure, and are hence called ivory-like osteomas.

Bony tumors may originate from bone or its accessories (cartilage and periosteum), when they are denominated exostoses, except when they project into the medullary cavity and are called enostoses. The projections of bony tissue found associated with diseased joints and inflamed bones, usually called osteophytes, are not tumors, but inflammatory formations. The former are frequent upon the interior or exterior of the skull, the jaws, great toe, humerus, and femur; the latter about diseased joints, muscles, and other structures undergoing inflammatory process. Osteomas occasionally arise from the medulla of bone. Bony tumors are non-malignant, but may require removal because of deformity, interference with motion, pain, or ulceration of the overlying integument. Excision by bone-cutting forceps or saws, or grinding away with the burr of the surgical engine is the proper method of accomplishing removal. Subcutaneous sawing or drilling followed by fracture may be valuable by affording relief of symptoms without entire excision.

Myxomas, or Mucous Tissue Tumors.—The most familiar growth of this class is the mucous tumor or polypus found in the nasal cavities. Myxomas are soft, often fluctuating, smooth or somewhat lobulated, painless tumors, of slow growth, and surrounded by a thin capsule. On section they are yellowish-white or pinkish in color, and exude an abundant glairy fluid, which examination shows to be mucus. The gelatinous consistence and intercellular mucous fluid are the physical characteristics of the growth, which consists of mucous tissue, such as is found in the

vitreous body of the eye and in the umbilical cord. Mucous tissue, which must not be confounded with mucous membrane, is a form of connective tissue which is translucent and possesses between its cells a fluid containing mucin. This resembles very much the connective tissue of the embryo, and, therefore, some authorities class myxomas with sarcomas.

Mucous tumors are always developed from some connective tissue, such as adipose tissue, bone marrow, or the connective tissue of the nervous structures and other organs. They may exist in combination with fatty, cartilaginous, sarcomatous, and other growths, and may undergo cystic change. On the other hand, various neoplasms may present a mucoid degeneration in spots which gives them the semblance of myxoma. Some tumors called colloid carcinomas are myxomas.

The microscopical examination discloses oval, stellate, and spindle-shaped cells, which are generally nucleated and often possess elongated projections which mutually interlace. The intercellular substance is more or less hyaline, and is homogeneous. It is this that gives the mucous tumors their jelly-like nature and furnishes the mucous fluid, so characteristic of them.

Myxomas, if not associated with sarcoma, are benign; and if entirely removed, seldom, if ever, recur. Where there is a group of pendulous myxomas, as occurs in the nose, the removal of a large one may, by relieving pressure, allow smaller ones to increase, and thus reproduce the old symptoms; but this is not a recurrence of the original growth.

Fig. 15.

Section of myxoma, showing cells and interlacement of prolongations. × 200. (Green.)

Fig. 16.

Section of a hard lymphoma, showing thick network and few small cells. × 200. (Green.)

Lymphomas, or Lymphatic Tissue Tumors.—These tumors are composed of lymphoid tissue similar to that which is found in lymphatic glands, Malpighian corpuscles of the spleen, Peyer's patches and solitary intestinal glands, the tonsils, thymus, pleura, marrow of bones, etc. They occur most frequently in adolescents or young adults; if of rapid development they are soft and often become very large, while if of slower growth they are hard and seldom attain any considerable size. Lymphomas may be found in almost any situation because, as is now known, lymphatic tissue exists physiologically in many localities formerly considered destitute of this structure. The usual original site, however, is the lymphatic glands of the neck, axilla, groin, thorax, or abdomen, whence the growth may extend by infiltration to other structures. The ordinary inflam-

matory enlargement of lymphatic glands gives the same microscopical appearance, and such swellings may be considered lymphomas if they continue to increase in size, and even when they merely persist without diminution of bulk.

Lymphatic tumors may be lobulated because of successive involvements of a group or chain of glands; they are usually painless and do not tend to suppuration or degenerative changes.

The microscope reveals a network of fibrils containing in its small meshes lymph corpuscles which are identical with white blood-cells.

These cells sometimes show one or more nuclei, and sometimes are granular with no visible nucleus. At the points where the fibrils of the network or stroma cross, nuclei are occasionally seen. In rapidly developed lymphomas the cells are abundant and large and the stroma not very marked. These are the softer in consistence, and allow considerable milky juice to be scraped from a cut surface. When the tumor has grown slowly the network or reticulum is found to be well-developed and the cells small and relatively few in number. These are the hard variety of lymphatic tumors.

Lymphomas are, as a rule, non-malignant, but those growths which are of rapid growth and richly endowed with cell elements sometimes infiltrate adjacent tissues and exhibit a malignant tendency. They are allied to the sarcomas. Lymphomas do not show a tendency to caseation or softening as do tuberculous lymphatic glands.

Multiple lymphomas constitute an essential clinical feature of Hodgkin's disease, which is a peculiar affection accompanied by intense anæmia. In leukæmia also we have lymphatic growths among the pathological changes present, but in this disease there is an increase of the white and a diminution of the red blood-cells, which conditions do not pertain to Hodgkin's disease.

The removal of lymphatic tumors may be undertaken if the growths are accessible and the patient in fair health. When the blood alterations associated with the existence of the tumors are evidently profound, as in Hodgkin's disease and leukæmia, no operation would be advisable or justifiable.

II. *Tumors whose general structure or type resembles that of one of the higher or more complex tissues than fully developed connective tissue.*

Myomas, or muscular tumors, are growths consisting of non-striated muscular fibres usually combined with more or less connective tissue. Very rarely muscular tumors are formed of striated muscular tissue (rhabdo-myomas): these have been usually, if not always, congenital tumors. Myomas are of slow growth and are usually circumscribed by a sort of capsule, though at times they are not distinctly bounded; not infrequently they become pedunculated. They possess considerable firmness and solidity, are often multiple, and are benign. Their most common location is in the uterus, prostate gland, and digestive tube; hence, they show the characteristics of involuntary muscular tissue. From the abundance of connective tissue found associated with the bundles of muscular fibres, especially in long-standing tumors, these growths, when in the uterus, are often termed uterine fibroids or fibro-myomas. Myomas may undergo calcareous and cystic degeneration.

Under the microscope are seen long fusiform cells of involuntary muscle, with their characteristic rod-like nuclei, arranged in bundles or irregularly disseminated through the tumor. There is seen also, except in some recent tumors, a good deal of fibrous tissue. Myomas are inno-

cent, but should be removed if it is possible to do so, when their location or their production of uterine hemorrhage demands operative relief. When such uterine tumors are developed near the lining mucous membrane, especially if pedunculated, they may be removed by forceps or écraseur. They are occasionally expelled by inducing uterine contraction with ergot. It may be necessary and advisable to remove the entire uterus by abdominal incision when such growths cannot be enucleated from the abdominal surface of the womb.

Neuromas, or Nervous Tissue Tumors.—All tumors connected with nerve-trunks are not neuromas, for they may be fibromas, myxomas, etc.; nor are nervous tumors necessarily painful tumors, as might be supposed by some readers. A neuroma is a rare form of growth and consists principally of ordinary white or medullated nerve-fibres. Gray nerve-tissue may be found in neuromas, but it is exceptional.

Such tumors are small, slow of growth, sometimes multiple, perhaps painful, and always develop in the course or at the end of a cranial or spinal nerve. A not infrequent situation is the end of a nerve-branch that has been divided in a previous amputation; here they may be compressed in the cicatrix and give rise to much pain. The so-called painful subcutaneous tubercle is a fibroma, not a neuroma.

Under the microscope nerve structure with some connective tissue is seen. Nervous tissue tumors are never malignant, but may require excision when painful.

Angiomas, or Vascular Tumors.—Tumors consisting of newly-developed vessels, bound together by cellular tissue, are angiomas; hence dilatations of existing vessels, such as are present in varicose veins and varicose arteries, often called cirsoid aneurisms and aneurisms by anastomosis, are not properly termed angiomas.

Simple angiomas consist of structures resembling normal vessels with unusual tortuosity and may have a predominance of venules or arterioles. The color of the growth varies on this account from pink to dark-red or purple. Such tumors are apt to be congenital and small; and, sometimes, present no elevation of the skin, being mere stains. They constitute the well-known nævus maternus or mother's mark.

Fig. 17.

Cavernous angioma of mouth and cheek in a child of two and a half years.

Cavernous angiomas are tumors which are made up of erectile tissue. This consists of a series of chambers, lined with endothelium and filled with venous blood, which circulates freely through these mutually connected spaces. The walls of the chambers are fibrous septa. The structure is similar to that of the cavernous portion of the penis, and gives such tumors an erectile character, which is often accompanied by distinct pulsation.

Cavernous angiomas are usually of a blue tint; vary in size according to the amount of engorgement, though ordinarily giving rise to distinct prominence; often grow rapidly, especially in cutaneous and loose areolar

tissue; and are not markedly congenital. Injury to cavernous angioma is followed by profuse hemorrhage.

Lymphatic vessels sometimes communicate with cavernous spaces, similar to those described as occurring in cavernous angiomas. A tumor is then formed, which is called a cavernous lymphangioma. There is also a form of lymphangioma which consists simply of a mass of lymphatic vessels; being, in fact, similar to the simple angioma above described.

The treatment of vascular tumors will be described in the section devoted to diseases of the bloodvessels more fully perhaps than here. They are non-malignant; but some forms may tend to produce death by hemorrhage, occurring from slight abrasion of their surface or from ulceration.

No treatment is demanded for angiomas which do not increase, nor threaten life from ulceration and hemorrhage, unless the deformity or personal disfigurement is a source of anxiety. Sometimes, though rarely, they atrophy spontaneously. Capillary dilatations situated solely in the skin, causing the pink discolorations often called port-wine marks, may be removed by puncturing with red-hot needles or electrolytic needles, or by applying caustics, such as chromic acid. These marks are often unaccompanied by any increase in the bulk of the part. Under such circumstances they can scarcely be called, with propriety, vascular tumors. Some of these superficial congenital discolorations gradually increase in thickness, and become true angiomas.

Purely subcutaneous angiomas present themselves as spongy, doughy tumors, from which pressure expels the blood more or less completely, leaving in the fingers a much smaller tumor. If largely composed of arteries, they have a pulsatile character, and a murmur which causes them to resemble aneurisms. The pulsation, however, partakes rather of the character of a thrill than of a beat synchronous with the heart movements. The spongy consistence and the fact that pressure on one artery does not obliterate the thrill and murmur aid in diagnosis. The angioma, moreover, is, probably, not located in the course of an artery. Angiomas in bone resemble malignant tumors.

Vascular tumors, which involve both the skin and the subcutaneous tissue, are easily diagnosticated. They may cause great deformity, and even erosion or displacement of the bones. The treatment of the subcutaneous angioma and of this last form is identical, except that in the former case the skin should be lifted up in one or more flaps and preserved if excision or strangulation of the tumor is practised.

The three methods of dealing with these tumors, which are sometimes called thick nævi, are injection of coagulating liquids, strangulation and excision. I believe the last to be the best in nearly all instances. Injection is accomplished by introducing the needle of a hypodermatic syringe into the centre of the growth, and after tearing the tissue somewhat by to-and-fro movements of the needle-point, forcing twenty minims of the liquid into the meshes of the tumor by means of the piston. Tincture of the chloride of iron, or a watery solution of similar strength, or chloride of zinc (gr. x to the fluidounce of water), are proper agents to employ, if this treatment is adopted. There is, however, danger of causing disfiguring scars from sloughing following the induction of too high a grade of inflammation. Fatal embolism has also occurred from fragments of the coagulated blood being washed into the general circulation. This may be guarded against to some extent, by previously encircling the tumor

with a ligature, or with a ring of metal or rubber, which is kept in place for a few minutes after the injection. The temporary ligature may be adjusted and kept from slipping, with more ease, by transfixing the tissue under the base of the tumor with a pin, under the ends of which the ligature is passed.

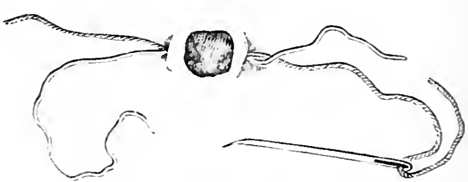
Strangulation may be accomplished in three ways: An acupressure pin is thrust through the tissues under the base of the tumor, after which a stout cord is carried once around the mass under the ends of the pin, and is then tightly tied. Sufficient force should be used in making the knot to cut off all access of blood to the tumor, which soon sloughs oft, leaving an ulcer to heal.

It is often well to puncture the constricted tumor with a needle before making the second tie, in order to let the blood and serum imprisoned therein escape. The tumor thus becomes more flaccid and shrunken, and the string can, probably, be tied more tightly. Two pins thrust through at a right angle to each other are better than a single pin, unless the nævus is small. If the string has cut a groove, in which it will lie without slipping over the top of the tumor, the pin or pins may be pulled out after the knot has been tied; otherwise, the pin must be left in position until the parts have sloughed. A second method is to pass a double ligature under the base by means of a large ordinary needle, or one with a handle having an eye in the point. The two halves of the tumor can then be constricted by cutting the string and tying on each side.

Fig. 18.

Strangulation of vascular tumor by a pin and ligature.

Fig. 19.



Ligation of vascular tumor in halves by a double ligature passed under it.

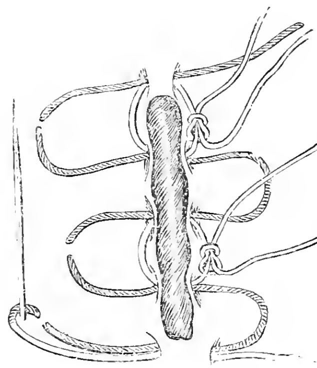
If the tumor has an extensive area, the double ligature, of which one-half should be stained black with ink, may be carried repeatedly through the tissues by a large ordinary needle. Between each puncture of exit and entrance a long loop of the double string must be left. By cutting with the scissors the stained threads on one side, and the white threads on the other, a series of ends are made which can be tied together to strangulate the tumor in sections. The adjacent ends of the separate portions of the ligature may be twisted around each other before the loop's arcs are tied, if there is danger of bleeding from the tying pulling the edges of the needle's punctures apart.

Occasionally constricting a portion of an angioma has set up sufficient inflammation to obliterate the whole. The subcutaneous ligation of the whole, or of sections of the tumor, may be done by carrying a wire around the growth in the same way as desciibed in the treatment of varicose veins.

This plan is well adapted, perhaps, to subcutaneous angioma, which may possibly atrophy without causing ulceration and scarring. The needle must, of course, be reëntered every time at the orifice of exit.

The third method of strangulation is a combination of the other two. First thrust a pin under the mass, then pass a needle carrying a double ligature under the pin and at a right angle to it. The two halves of the growth can then be tied, and the ligature will not slip over the sloping edge of the tumor. All of these operations must be carried out with antiseptic care.

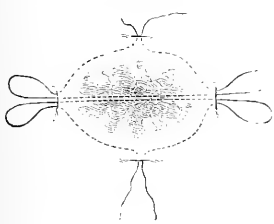
FIG. 20.



Ligation of large vascular tumor in sections. The corresponding loops of the black and white threads are tied together.

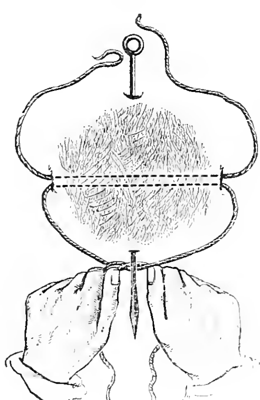
Excision of angiomas is, as a rule, I think, the best treatment. The tumor is thoroughly eradicated, the wound, if aseptic, heals more rapidly than the ulcer left after ligation, and there is not the offensive sloughing mass that remains unseparated for many days after ligation. Hemorrhage of a serious character is avoided by making the incision beyond the margins of the growth. When the spongy mass of vessels is removed, sutures are applied and the wound treated as after removal of any other tumor. The method much used by Levis, of Philadelphia, to prevent hemorrhage during the removal of these and other tumors, when even

FIG. 21.



Ligatures inserted subcutaneously around the base of a vascular tumor before being tied. (BRYANT.)

FIG. 22.



Method of ligating a vascular tumor in halves by means of a pin and ligatures. (BRYANT.)

moderate bleeding is undesirable, is worthy of notice. Before making his first incision he introduces deeply through the tissues surrounding the growth, and at some distance from it, numerous long acupressure pins,

and then constricts the tissues and afferent vessels by strong cords tied around the ends of these pins, as in the pin or harelip suture. If the location is not convenient for using the pins, he carries strong cords through the tissues by means of specially made needles six or eight inches long, and ties the ends of the cords on the surface of the skin. The access of blood to the region of operation is thus more or less completely prevented. After the incisions have removed the tumor, the pins or strings are removed one at a time, and the bleeding arteries ligated systematically. This method is easily applied, and requires no special skill for its successful employment if the surgeon only place the pins or ligatures at a sufficient distance from the growth to allow room for incision to be made entirely outside of its limits. The cord must be strong, and tied with much force. I have broken strong fishing-line in tying a knot before operating in this manner.

Lymphangiomas may be treated by ligation and excision, as described for the removal of arterial and venous tumors, if their extirpation is demanded.

Papillomas, or Papillary Tumors.—These growths resemble, and are usually, hypertrophies of the papillæ of the part, and are covered by the variety of epithelium which belongs to the region. They seem to owe their origin to direct inflammatory irritation, and are of slow growth, though they may attain considerable bulk by coalescence of several smaller masses. When the epithelium is abundant enough to cover the numerous papillæ and fill in the crevices between them, the tumor is somewhat smooth; but usually the various papillæ and their branching outgrowths are separate, and give the growth a ragged or cauliflower appearance. Papillary tumors occur upon cutaneous, mucous, and serous surfaces, and present characteristics depending upon location. Sometimes they become pedunculated, and constitute one form of polypoid tumor. Warts, as well as many horny growths and corns, are cutaneous papillomas. These have a hardened epithelium, except when kept moist, as soft corns are, and possess limited vascularity. The papillary tumors found about muco-cutaneous junctions and upon mucous membranes are larger, non-vascular, and softer. They occur especially about the anus and genitals, where irritating discharges cause their exhibition, and are also found in the bladder, larynx, etc. Serous papillomas are met upon the synovial membrane of inflamed joints. The soft variety of papillary tumor may become the seat of ulceration or hemorrhage. Many such excrescences about the anus and genitals were formerly described as syphilitic, but they have no specific origin, except in so far as the irritation of the mucous membrane may in some cases be the result of a venereal discharge. Any other chronic irritating secretion will induce similar growths.

A papilloma consists of a projection of connective tissue, usually quite full of small round-cells, surrounding a loop or plexus of capillaries, and covered by a layer of epithelium. Papillary tumors are benign, having the epithelium only on the surface, and not distributed through the mass, as in epitheliomas. They may become malignant, however, by transformation into epithelioma. Warts of a pigmented kind occur frequently in the aged. They should not be irritated, as they may thus be excited to assume malignant tendencies.

Papillomas on mucous surfaces may give rise to hemorrhages; and in the bladder and urethra may obstruct urinary evacuation.

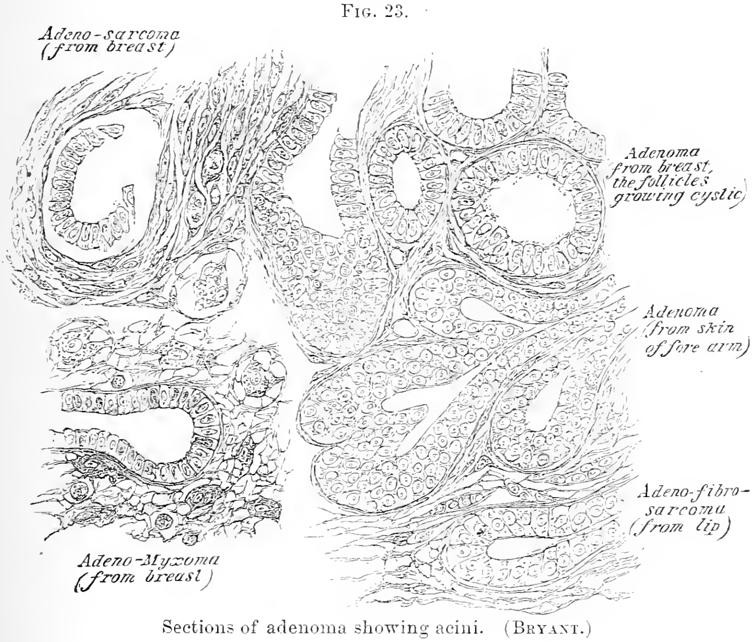
Papillomas should be treated by removal with caustics, ligatures, or

excision. Occasionally the hemorrhage which follows excision will be severe. Powdered tannic acid smeared over the bleeding surface is a good styptic, especially if combined with pressure for an hour or more.

ADENOMAS, OR GLANDULAR TUMORS.—Glandular tumors consist of such tissue as is found in secreting glands (the simple tubular glands of the mucous membranes and the compound, or racemose, glands, such as the mamma and parotid); but the tissue is not capable of performing function as a gland. They must not be confounded with lymphatic gland tumors, which have a very different structure and are called lymphomas. The tubular adenoma is found originating from mucous membrane, as of the vagina, rectum, stomach, and is often so closely allied to epithelioma that a distinction is well-nigh impossible. Racemose adenomas occur in the breast especially, and are often associated with fibrous and sarcomatous tissue, thus forming compound tumors.

Adenomas are of slow growth, may be lobular in form, are quite firm unless undergoing cystic degeneration, are usually surrounded by a capsule, and, when uncomplicated with other morbid growths, are benign. They sometimes undergo, in places, fatty or cheesy transformation. Glandular tumors of mucous membrane sometimes become pendulous and thus constitute a form of polypoid tumor.

FIG. 23.



Sections of adenoma showing acini. (BRYANT.)

Tubular adenomas show under the microscope tubules, resembling the follicles of the intestine, lined with epithelial cells; racemose adenomas exhibit a series of pockets, or acini, lined with one or more rows of epithelium. Between the acini is connective tissue in varying quantity, sometimes containing numerous cells.

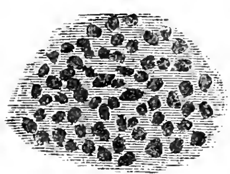
True adenoma is benign, but its frequent association with sarcoma, and its tendency at times to become epitheliomatous, render its extirpa-

tion usually desirable; especially is this the case because of the liability of error in clinical diagnosis.

III. *Tumors whose general structure or type is that of the undeveloped tissue of the embryo (Sarcomas).*—Tumors consisting of connective tissue similar to that found in the human embryo are called sarcomas, and present variations according to the peculiarities of the cells and intercellular substance. The connective tissue of the embryo, before it is developed into the mature connective tissue of the fœtus, consists of numerous small, round cells, with a very small quantity of soft and homogeneous material between them. As the connective tissue becomes more mature, the cells decrease in number and assume an elongated shape, while the intercellular material spoken of becomes fibrous. This maturing connective tissue finally develops into the perfect connective tissue, fibrous tissue, cartilage, and bone of the fœtus and child.

Sarcomatous growths are formed then of embryonic connective tissue, which, instead of maturing, continues to exist and to reproduce itself, thus causing progressive increase of the tumor. Small portions of the tumor occasionally reach a higher development and become fibrous tissue, cartilage, or bone, thus producing a mixed tumor; but this is not general or usual. The cells of sarcomas may be round, spindle-shaped, or very large and irregular. They are closely packed together with very little intercellular substance, which varies from a homogeneous fluid to a somewhat granular or fibrillated material having considerable firmness, but which usually intervenes between all the cells, and does not allow them to congregate together in groups.

FIG. 24.



Round cells. × 350. (GREEN.)

FIG. 25.

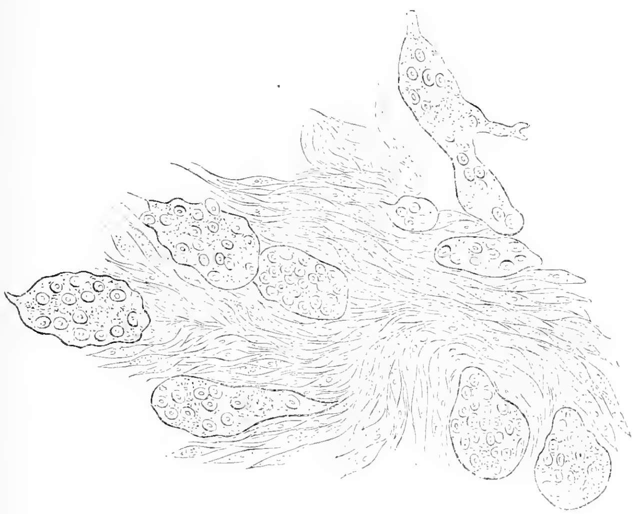
Spindle cells. × 350. (GREEN.)

These cells may all occur in one tumor, but the form which predominates gives name to the variety, viz.: round-cell, spindle-cell, and giant-cell sarcoma. The round cells are either identical in appearance with white blood-cells, or they may have an indistinct nucleus and bright nuclei.

The spindle or fusiform cells are oblong, terminate in fibrils, and have a long elliptical nucleus, with or without a nucleolus. The large irregular or giant cells, called myeloid cells because they resemble the cells of fœtal marrow, are very much larger than the others, and are irregularly spherical with perhaps several prolongations, and contain many oval nuclei with bright nucleoli. They may not actually predominate in the tumor, but their presence is so evident that they give name to the variety in which they are seen. The bloodvessels in sarcomas are numerous, and on account of the small amount of matrix are scarcely separated from direct contact with the cells.

Sarcomas always develop from connective tissue; hence, they have a general distribution and are found originating from muscular fascias, periosteum, lymphatic glands, and marrow of bones, as well as from the ordinary connective tissue beneath the skin and the cellular tissue of the viscera. They infiltrate the surrounding structures and thus extend by cellular invasion. There may be a sort of capsule, though the growth is usually diffuse. Fatty, cystic, calcareous, and other degenerations are liable to occur in portions of the growth; and sometimes sarcoma may be combined with other forms of tumor. This assumption of, or combination with, sarcomatous elements accounts for the malignancy of certain tumors which are usually classed as benign. This has been referred to when speaking of osteomas and chondromas.

Fig. 26.



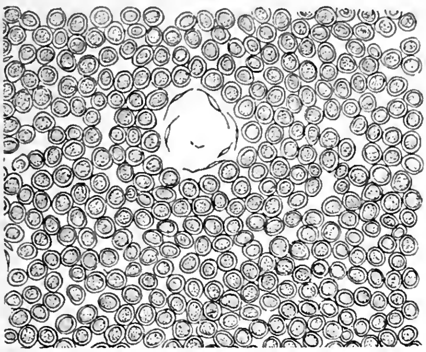
Giant or myeloid cells. (Green.)

Sarcomas are not as common in old age as in the earlier period of life. Many sarcomas are very malignant, infiltrating adjacent parts, recurring after removal, and finally producing secondary growths in the lungs and other regions. The round cell and the large spindle-cell growths are much more malignant than the small spindle or giant cell tumors. Soft and very vascular sarcomas are to be looked upon as being probably highly malignant. Sarcomas do not often affect the lymphatic glands, while the carcinomas do so with great frequency. The fact that the bloodvessels in sarcomas are in close relation with the cells accounts for the occasional rapid development of secondary tumors without lymphatic involvement. The cells readily penetrate the thin vessel walls and are carried along with the blood-current. In carcinomas, as will be seen later, the bloodvessels run in the fibrous network, or stroma, at a distance from the cells, which lie grouped in alveoli or pockets. Hence, dissemination usually proceeds along the lymphatic channels before infection by the blood-current takes place.

Round-cell sarcomas present round cells which are similar to granula-

tion cells, which are larger than leucocytes and have an indistinct nucleus with nucleoli. These round cells are seen lying in a soft homogeneous or granular intercellular substance or matrix. The structure is, in fact, that of the primitive tissue of the embryo.

Fig. 27.

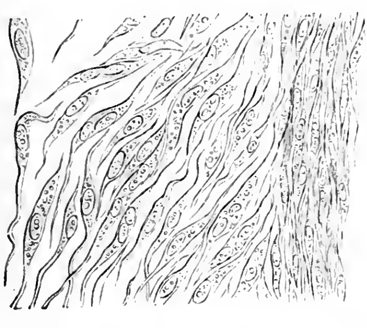


Small, round-cell sarcoma, showing vessels with mere embryonic wall. × 400.

Round-cell sarcomas are soft, and gray or pinkish in color upon section; furnish a juice when scraped; are very vascular, and hence, are often stained by rupture of vessels and are liable to contain blood cysts. They rapidly infiltrate neighboring parts, give rise to distant secondary growths, may even involve lymphatic glands, and in many other characteristics resemble clinically the form of carcinoma called encephaloid. The microscopic appearances serve to distinguish them from encephaloid with its stroma and grown-up cellular elements. Round-cell sarcomas are, of course, as seen by their above-mentioned tendencies, very malignant. Glioma, the round-cell tumor found in the brain, retina, and cranial nerves, is a sarcoma. There is a round-cell sarcoma which shows an excess of intercellular structure in certain portions of the growth, so that there is a resemblance to the stroma of carcinomas. This has been called the alveolar sarcoma.

Spindle-cell Sarcomas.—These are the most frequently found of the sarcomas, and consist of elongated cells with distinct oval nuclei and

Fig. 28.



Large spindle-cell sarcoma. Some cells teased apart. (Virchow.)

Fig. 29.

Giant-cell sarcoma. × 280. (Holmes.)

nucleoli. The cells lie close together in parallel rows with little intervening substance, and sometimes give rise to a fibrous appearance until they have been teased apart to show their characteristic shape. If the spindle cells are small the growth is rather hard and probably is surrounded by

a capsule. Although it will recur after removal and will spread by infiltration of surrounding tissues, it has little disposition to infect the internal organs and possesses much less malignancy than the large spindle-cell variety, which is soft, more vascular, and exceedingly liable to give rise to distant secondary tumors. Sometimes the cells are so broad as to be really oval in form. The small-cell growths are the recurrent fibroid tumors of the older writers.

Sometimes spindle-cell sarcomas contain pigment granules deposited in the cells. This occurs especially when the tumor arises from a tissue containing pigment, as, for example, the choroid coat of the eye. These melanotic sarcomas are very liable to induce secondary pigmented growths in the internal organs, and are, therefore, very malignant, even if they have less disposition to local extension than some other forms. This tumor a few decades ago was often denominated black cancer.

Calcareous and osseous degeneration occasionally occurs; then the term osteoid sarcoma is used. This is very different from the benign growth called osteoma.

Giant-cell or myeloid sarcomas.—These tumors usually arise from bone and especially from the marrow. They contain large multinucleated cells, like those of fœtal marrow, associated with spindle cells, and show little substance between the cells. The nuclei of the myeloid cells contain bright nucleoli. Myeloid sarcomas are usually quite hard, may be vascular, and frequently contain cysts. When they grow from the medullary canal the bone is expanded before them, and therefore manipulation of the tumor may cause a crackling noise. They frequently occur in the extremities of the long bones and in the jaws. They are less malignant than the round and spindle-cell varieties of sarcoma.

IV. *Tumors whose general type is that of epithelial tissue* (*Carcinomas.*) —The carcinomas consist of a fibroid network or stroma within the meshes or alveoli of which numerous cells of an epithelial type (epithelioid cells) are crowded together without any intermediate substance. A carcinoma may be readily illustrated by a piece of sponge (the stroma) within the cavities (alveoli) of which numerous grains of sand (cells) are grouped. A sarcoma, on the contrary, is represented by a quantity or mass of sand of which the grains (cells) all lie closely together with no sponge or stroma to form distinct spaces (alveoli) for their reception.

Fig. 30.

Cells from a scirrhous carcinoma of breast. × 350. (Green.)

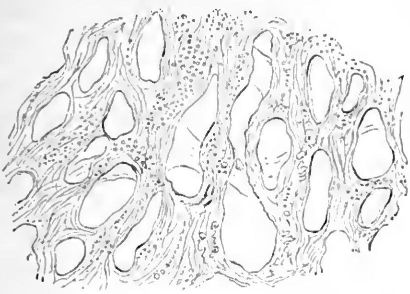
The cells of carcinomas are about five times as large as a red blood-corpuscle, have a variety of shapes on account of their mutual pressure, possess large, well-marked nuclei and nucleoli, and, though there is no intercellular substance between the cells, have some fluid filling the spaces between them. The cells frequently show molecules of fat within them due to fatty degeneration, and indeed the cells may be entirely destroyed, so that only the free nuclei remain.

It must be borne in mind that similar cells are seen in these morbid growths as in normal tissues. It is the characteristic arrangement of the cells, the variety of their shape and the stroma that distinguish carcinomas. There is no special carcinoma cell.

The fibrous network or stroma of carcinoma is a more or less fibrillated structure so interlaced as to leave numerous communicating irregular spaces called alveoli, within which the cells already described are impris-

oned. The amount of stroma varies very much and with its abundance the hardness of the tumor increases. It sometimes, especially if of rapid development, contains in its own structure a few cells. In the stroma, forming as it does the walls of the alveoli, the bloodvessels ramify. Hence the cells of carcinoma are separated from the vessels and do not as readily as in sarcoma enter the blood-current and cause rapid dissemination of the growth. The lymphatic vessels, however, which accompany the bloodvessels in the stroma, open into the alveoli, and thus readily allow entrance of cells into the lymphatic stream. This accounts for the early involvement of the neighboring lymphatic glands in cases of carcinoma, and its more frequent occurrence than in sarcomas.

FIG. 31.



Stroma from carcinoma. × 220. (HOLMES.)

Carcinoma cells originate from preëxisting epithelium, and therefore carcinomatous growths occur only where epithelium exists, as in the glands and cutaneous and mucous structures. This at least seems to be the opinion with most authority in its favor. After a time the epithelial cells burst through the epithelial basement membrane from which they originated and thrust themselves among other tissues. This has probably given rise to the opinion that they developed from other than epithelial structures. The stroma of carcinoma is partly newly developed tissue and partly the previously existent connective tissue of the part.

The degenerative process occurring in carcinomas most frequently is fatty transformation which is always observable in a greater or less degree. It sometimes converts the tumor into a pulpy mass. Cystic degeneration sometimes occurs. Abscess may, though rarely, occur.

The structure and clinical characteristics of the carcinomas have caused their division into these varieties:

Acinous Carcinoma:

- *a.* Scirrhus, or Chronic Carcinoma.
- *b.* Encephaloid or Acute Carcinoma.

Epithelial Carcinoma:

- *a.* Squamous Epithelioma.
- *b.* Columnar Cell Epithelioma.

Any of these may undergo colloid degeneration and become the so-called Colloid or Gelatiniform carcinoma.

The clinical characteristics of the carcinomas are important. They are exceedingly malignant, though epithelioma is usually less so than encephaloid and scirrhus. They differ from sarcomas in that they generally infect the neighboring lymphatic glands and do not produce secondary tumors in the internal viscera until after the lymphatic glands in the vicinity of the primary growth have been affected for a considerable time. Sarcomas, on the other hand, rarely involve the lymphatics, but rapidly appear in the viscera, because of their dissemination by means of the bloodvessels, which have thin walls and ramify among the cells instead of running in a stroma.

Epithelioma much less rarely reproduces itself in the viscera than the

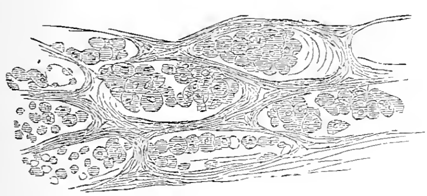
other forms of carcinoma, though it ulcerates earlier. It usually, however, infiltrates the adjacent tissue and involves the neighboring glands. The more rapid and the more vascular a carcinoma is, the greater are its malignant qualities; hence, encephaloid may be considered as having the greatest degree of malignancy. The secondary growths produced by carcinomas are usually of the same varieties as the primary tumor. If a carcinoma is incised, a comparatively abundant whitish juice can be scraped from the cut surface. This consists of the fluid and cellular elements of the growth.

Ulceration, sometimes attended by hemorrhage, is of frequent occurence in carcinomatous disease. Pain, of a darting character, is a not infrequent symptom.

The word "cancer" was formerly much employed to designate malignant growths. This was before the days of accurate pathological and microscopic investigation. Now, some authors attempt to limit the term to the class "carcinoma." This produces an unnecessary confusion, for "cancer" has and can have no accepted scientific definition. It has no greater etymological value in the scientific surgery of the present time than has "hives" in dermatology, or "amaurosis" in ophthalmology. The word, therefore, should not be retained in surgical literature.

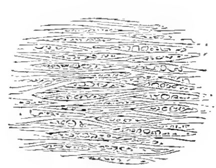
Scirrhus, or chronic or hard carcinoma, grows very slowly, is very hard, is apt to be nodular, seldom attains a large size, and occurs usually in rather advanced adult life. At first it is unconnected with the overlying skin, but soon becomes attached to the integument, and causes puckering and retraction thereof. As the disease advances the lymphatic glands in the vicinity become enlarged and ulceration of the skin over the primary growth occurs, producing an ulcer with ragged and nodulated irregular edges, secreting a foul mixture of sanious pus and blood. The pain in scirrhus, when present, is of a shooting or neuralgic character. Scirrhus is most frequent in the female mammary gland, and in the various parts of the alimentary tract. When the internal organs are involved secondarily, it may assume the form of encephaloid. Section of a scirrhous mass causes creaking as the knife divides the hard fibroid tissue, and shows a whitish shining surface, usually traversed by fibrous lines, and often concave on account of contracting influences.

Fig. 32.



Section of scirrhus taken from newly developed portion of tumor. × 200. (Green.)

Fig. 33.



Section from interior of scirrhus, showing atrophy of cells and diminution in size of alveoli. × 200. (Green.)

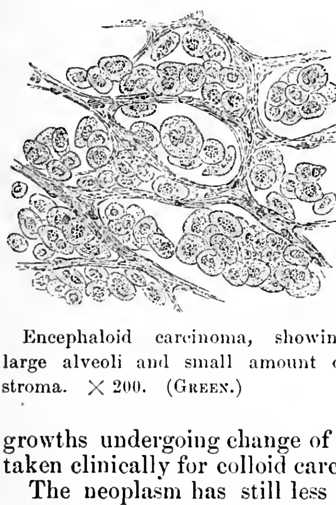
Microscopic examination reveals a very large amount of stroma. This, by contraction and hardening, finally causes atrophy and disappearance of the epithelial cells, and almost obliterates the alveoli. Hence, the interior, or older portion of a scirrhoma, approximates in appearance

fibrous tissue, while the exterior or newly developed structure shows the alveoli and the groups of epithelioid cells.

Encephaloid, or acute or soft carcinoma.—This morbid growth is soft, having the consistence of brain tissue, grows rapidly; is very vascular, frequently showing large veins traversing the overlying integument, and when it ulcerates, gives rise to a fungous protrusion which is the seat of hemorrhage. Sometimes pulsation is perceptible, on account of the numerous large arteries in its structure. Encephaloid is not as frequent a growth as scirrhus, and it is found usually in the viscera as a secondary growth following a primary scirrhus of external parts. It does occur, however, primarly at times, especially in the testicle and breast. Many tumors of the eye and of the bones occurring particularly in young adults or children, formerly described as encephaloid disease, are now recognized as sarcomas. On section encephaloid tumors show a brain-like pulpy substance stained by blood extravasations and sometimes quite fluid from fatty degeneration.

Encephaloid can scarcely be described as an entirely distinct growth from scirrhus; but its softness, its greater rapidity of growth, its less amount of stroma and absence of contractile tendencies, its vascularity, and its abundance of cells rapidly undergoing fatty degeneration warrant its designation by a separate name.

FIG. 34.



Encephaloid carcinoma, showing large alveoli and small amount of stroma. × 200. (GREEN.)

Under the microscope the observer finds large alveoli, surrounded by a limited amount of stroma, and containing rather large cells, undergoing fatty change, accompanied by many free nuclei.

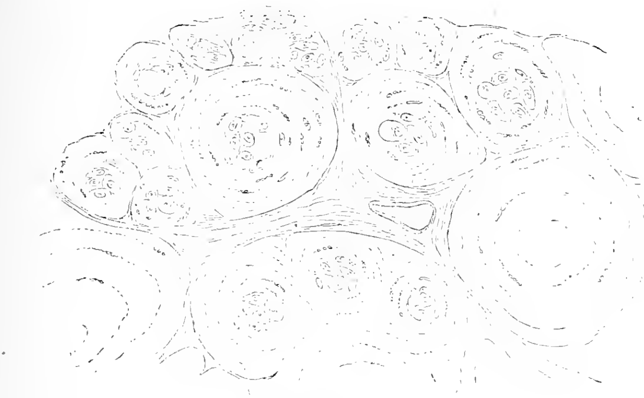
Colloid, or gelatinous carcinoma.—Colloma is a soft, jelly-like tumor, occurring most frequently in connection with the peritoneum, intestines, and stomach. It is a colloid or mucoid degeneration of scirrhus, encephaloid or epithelioma. Lipomas, chondromas, myxomas, sarcomas, and other growths undergoing change of a colloid or mucoid character may be mistaken clinically for colloid carcinoma.

The neoplasm has still less stroma than encephaloma, and the alveoli are large and very distinct, because of their distention with a mucilaginous or glue-like material. This colloid substance is transparent and colorless, or sometimes yellowish, and for the most part structureless, though a few epithelioid cells are seen. These cells are large and distended with the gelatinous material similar to that surrounding them. At times they differ little from ordinary carinoma cells. Sometimes they have a lamellar surface.

Epithelioma, or skin carcinoma. Squamous epithelioma.—This is a more distinct variety of carcinoma than the others, though it does, at times, approach scirrhus in its characteristics. It usually occurs at a mucocutaneous junction such as the lip, eyelid, ala of the nose, anus, and prepuce; and appears first as a small nodule under the skin or as a scab or an ulcerated abrasion or fissure. It not infrequently arises at the situation of moles or warts. The tumor is quite firm and shows on sec-

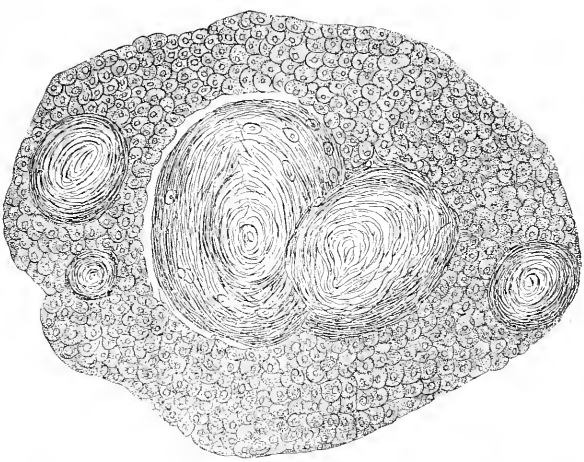
tion a whitish granular surface traversed by fibrous bands, from which a thick, curdy material, like sebum, can be pressed. The epithelial nests, to be described, can often be seen. Epithelioma is rare in young persons; soon exhibits ulcerative action, though of somewhat slow progress; commonly implicates the lymphatic glands but does not often infect the viscera; and is traceable to traumatic irritation of the muco-cutaneous tissues more frequently than the other carcinomas.

FIG. 35.



Colloid tumor, showing large alveoli and colloid contents. × 300. (GREEN.)

FIG. 36.



A lobulated pavement-cell squamous epithelioma showing pearly bodies. (Drawn by DR. CHARLES B. WILLIAMS.)

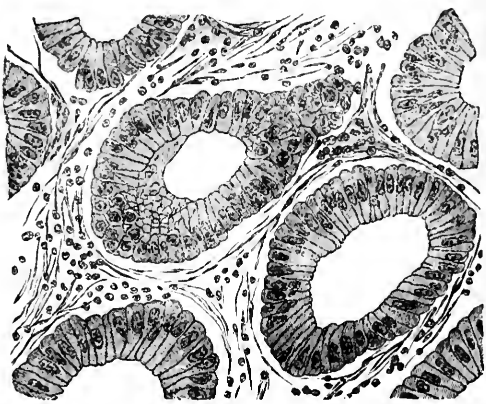
The cells of ordinary epithelioma resemble the squamous epithelium of skin and mucous membrane, and contain one or more nuclei. They may be flattened by pressure, but have not the varied shape of the other carcinomatous cells, nor do they so readily assume degenerative changes of a fatty kind. They are grouped in the alveoli of the stroma, some-

times as tubular prolongations or plugs, and tend to form nests or "pearls" formed of concentric layers of flattened cells, which resemble the structure of an onion. These epithelial globes or nests are very characteristic of epithelioma, though not essential. They grow down from the surface into the lymph spaces of the connective tissue like nails or plugs. They merely signify that there is a rapid growth of squamous epithelium and may occur in epidermic structures not carcinomatous.

The stroma is rarely so markedly alveolar as in the other members of the carcinomatous group, and may be quite limited in amount. It is represented by a fibrous like tissue or by a tissue filled with small round cells surrounding the epithelial nests.

Columnar epithelioma—When epithelioma occurs in the intestinal tract the cells are of the columnar or cylindrical variety found in the mucous glands of these parts, appear in more distinct alveoli, and usually do not form concentric nests. The growth closely resembles adenoma.

Fig. 37.



Columnar epithelioma of transverse colon. One alveolus is cut obliquely, the others transversely; the epithelium is irregular in shape and size and is sometimes arranged in more than one layer. The stroma is fibrous, containing small round cells. (Erichsen.)

Epithelioma originates from the epithelium of the skin, mucous membranes, and glands; and then the proliferation of epithelium which occurs causes invasion of the adjacent structures, whether they be connective tissue, muscle, or bone. It is the presence of epithelium in these unusual localities that is the essence of the morbid growth. Rodent ulcer is a form of epithelioma.

V. *Tumors consisting of a sac with contents (cystomas, or cystic tumors).*—A cavity separated from neighboring tissues by a sac wall and having fluid, semi-solid, or soft contents is called a cyst or cystic tumor.

Such tumors may result from the development of a sac-like cavity in tissues where no sac or cyst previously existed. These are true tumors or morbid growths, and are due to softening of structure, as occurs in fatty and mucoid degeneration; to separation of connective tissue by a secretion or deposition of fluid, as serous and blood cysts; and to the development of a sac around foreign bodies and parasites. In all these cases condensation and irritative development of connective tissue lead to the formation of a circumscribing capsule or sac wall.

Cysts are more frequently developed by slow accumulations within a

dilation of a preëxisting cavity or duct. These are not true tumors, but are usually conveniently considered as such in connection with the form just mentioned. The contents are the natural products or secretions of the part, more or less altered by the changed conditions to which they are subjected. Such cysts are developed when the duct of a secretory gland becomes occluded, as is the case in sebaceous, mucous, salivary, and other retention cysts; when a ductless cavity secretes more fluid than the absorbents can remove, as in hydrocele, bunion, and bursal tumors; when the blood is poured into a cavity, as in hæmatoceles.

The wall of a cyst may be thick or thin, tough or friable, slightly or firmly adherent to surrounding tissues, and is developed by condensation and new growth of the circumscribing connective tissue. In the second variety of cystic tumors the wall presents the features of the gland or membrane from which it was developed, and has a similar epithelial lining. Cysts may contain serum, saliva, milk, semen, sebum, blood, and other materials, and often take their name from the contents.

The congenital cysts, which consist of a wall resembling skin containing epithelial structures, and those cysts, enclosing teeth and bones, found in the abdomen and supposed to be imperfectly developed ova, are called dermoid cysts.

The hydatid cyst is a peculiar tumor due to the presence in the tissues of a parasite. This parasite is the undeveloped tænia echinococcus, which infests animals of the canine family but never progresses to full maturity in the human subject. The ovum having been introduced with food into the human system, develops as far as its cystic stage. The irritation due to the parasite in the tissues causes the formation of a sac or cyst wall from the surrounding parts: within this lies the parasite, which is itself a distended sac without any head, hence called an acephalo-cyst. It contains a transparent, non-albuminous or almost non-albuminous liquid of low specific gravity, in which are floating heads or the hooklets belonging to the heads of this form of worm. These heads are called echinococci. The echinococci may be adherent to the inner wall of the bladder like parasites. Hydatid tumors occur most frequently in the liver, lungs, muscles, and subcutaneous tissue.

Various changes occur in cystic tumors. Thus, the contents may become inspissated, fatty, or calcareous, and the wall may calcify, ossify, or even undergo cystic or other degenerations. Sometimes inflammation of the tumor supervenes, which leads to suppuration, discharge, or absorption of the contents, and cure by granulation.

Occasionally, instead of cicatrization occurring, a foul chronic ulcer is left.

A cystic tumor with one cavity is called simple or unilocular; one with several cavities, compound or multilocular. It must be remembered that many of the tumors previously described may undergo cystic degeneration by mucoid or fatty change taking place in their interior.

The treatment of cystomas consists in their removal or their obliteration by evacuation of contents and destruction of cyst walls. True cystomas are benign, but may, as other malignant growths, cause death by their situation and size. If they are excised every portion of the cyst wall must be removed, lest the part remaining become the starting-point for a similar tumor. Cystic sarcomas and other tumors that have undergone cystic degeneration must be treated as growths of their own class.

Obliteration of cysts may be accomplished by tapping, internal scarification, injection, and incision. If the contained fluid is not viscid it may

be withdrawn with a trocar or aspirator; this causes collapse of the sac. Usually the cyst refills, but occasionally the irritation resulting from the puncture is sufficient to cause plastic inflammation of the interior of the cyst and adhesion of the walls. Thus, obliteration of the cavity and cure result. The cure may at times be accomplished by scarifying the internal surface of the cyst wall with a tenotome or long needle thrust into it at one or at several points without evacuating the fluid, which escapes into the surrounding tissues and is absorbed, or undergoes absorption during the progress of the resulting inflammation. This method is very satisfactory in treating hydrocele in infants. Multiple puncture and abrasion of the vaginal tunic with a needle seldom fail to cure such cases. When tapping or scarification fails to induce obliteration of cysts with liquid contents, it becomes necessary to inject into the cavity some irritating fluid to set up inflammation of a plastic grade. The best agent is carbolic acid liquefied by moderate heat or a few drops of water or glycerine. Tincture of iodine, wine, and other irritating and astringent solutions may be employed. The quantity should vary from twenty minims to a fluidrachm, according to the size of the tumor, and should be left within the cyst cavity.

Cysts with thick cheesy contents, if not excised, should be split open. The surgeon must then scrape out the contents, and, if he does not remove the cyst wall, he must mop the interior of the sac with strong carbolic acid or some strong astringent or cauterizing application, and leave the wound open to granulate. This destroys the secreting surface of the wall and sets up inflammation, which, by means of the granulating process, causes the wound to heal and the cyst to become obliterated.

CHAPTER VIII.

WOUNDS AND SHOCK.

Definition.—A wound is a sudden and recent solution of continuity of the soft parts caused by mechanical violence. A solution of continuity of such tissue produced *slowly* by mechanical pressure or violence, or by inflammation idiopathically, is an ulcer; a solution of continuity of bone is called a fracture; hence, the term wound gives the idea of sudden violence to the soft tissues of the body. This mechanical violence is usually directed from without, but it may arise from within, as is the case when wounds are produced by muscular efforts or by the projection of fragments of bone in fractures.

Varieties.—Wounds are either freely exposed to the external air when they are called open wounds, or are protected from such exposure by the more or less perfect integrity of the skin, when the term subcutaneous is applied. A wound communicating with the air by a *small* cutaneous opening may still be considered a subcutaneous wound, as are also wounds beneath the mucous membranes, though the term, in this instance, is a misnomer.

For convenience of description I classify wounds under four heads: 1. Contused, or those in which the injury consists in a crushing or bruising of the parts, with or without rupture of the integument. 2. Incised, or those in which the tissues are divided cleanly, or cut, as by a sharp knife, and in which the length of the wound greatly exceeds its depth. 3. Punctured, or those in which a wound is made by a pointed instrument, and in which the depth exceeds the length. 4. Lacerated, or those in which the structures are torn apart, giving, therefore, irregular edges to the wound. All wounds are referable to one of these groups, though they may possess additional characteristics: thus, any wound infected with a specific poison becomes a poisoned wound; if the vulnerating body enters a cavity, as the chest or a joint, a penetrating wound results; and missiles thrown by the explosive force of gunpowder produce contused or lacerated injuries, called gunshot wounds.

Symptoms.—Contused wounds are produced by blows or by sudden forcible contact with surfaces that have no sharp edges. The typical contused wound is the ordinary bruise or contusion in which there is no laceration of the skin; ordinarily, however, contused wounds are lacerated wounds in which the bruising is a more prominent feature than the laceration. I consider a simple bruise or contusion a contused wound, because there is a solution of continuity of the subcutaneous tissues in all such cases. Contused wounds may involve the skin and superficial fascia only, or may extend also to the muscles and deep structures. I have seen the muscles of the arm so pulpefied that amputation was required, though the skin appeared scarcely injured. In persons with a great deal of subcutaneous fat a slight degree of pressure, as from a pinch with the fingers, will cause a distinct bruise, because the vessels are so readily ruptured. The characteristics of this class of wounds are dull

pain or numbness, a black and blue color at the seat of injury due to extravasation of blood from the ruptured capillary vessels, some swelling from effused serum, little or no hemorrhage from any accompanying laceration of the skin that may exist, and a tendency, if the contusion be severe, to the production of abscess and gangrene. Abscess and gangrene result because a place of least resistance is produced in the injured tissues and because the cellular vitality is impaired, thus giving opportunity for bacterial action.

When structures are divided by a keen instrument and the length of the wound is a more conspicuous feature than its depth the term incision or incised wound is employed. Incised wounds are characterized by acute pain and hemorrhage, a tendency to retraction or gaping of the edges, and rapid cicatrization. These features vary, of course, with the locality and extent of the injury. The bleeding washes away bacteria and tends to keep the wound aseptic, hence the rapid healing often seen.

Punctured wounds are those inflicted by a pointed instrument piercing the tissues, and hence they are remarkable for depth rather than for linear extent. A wound one inch long and a half inch deep made by a knife is an incised wound; one of similar extent, but three inches deep, is a punctured wound. Punctured wounds vary according as they are made with dull or sharp pointed instruments; in the former case they resemble lacerations, in the latter incisions. As a rule, however, it may be said that punctures are accompanied by great pain and slight hemorrhage. They are especially liable to be followed by severe inflammation, because they are not likely to be kept as free from bacteria as are those wounds which bleed profusely and which are readily cleansed.

Wounds produced by disruption or tearing asunder of the tissues are termed lacerations or lacerated wounds, and are frequently accompanied by contusion of the parts. In fact, a force which causes crushing of the tissues without much tearing of the integument, gives rise to a contused wound, while the same force, so applied as freely to rupture the skin as well as underlying structures, is said to cause a laceration. Lacerations are distinguished by irregular jagged edges, moderate pain, slight hemorrhage, little gaping, a tendency to suppuration and sloughing of the edges and slow cicatrization. These features depend upon the method of injury, for it is the tearing and twisting of the vessels and nerves that prevent bleeding and acute pain, and the devitalization and irregularity of the torn edges that occasion sloughing, favor microbic infection, and prevent rapid healing.

SHOCK.

DEFINITION.—The constitutional symptoms that *immediately* follow the receipt of a wound or injury, if it be sufficient to induce general disturbance, are grouped under the head of shock or collapse. Subsequently the general symptoms pertaining to inflammation arise, if the lesion is grave enough to cause an active process of this kind. Delayed shock I believe to be impossible. Cases so named are doubtless instances of fat embolism, sapræmia, septicæmia, or other imperfectly understood conditions.[1]

SYMPTOMS.—Slight shock is shown by pallor of the skin, a sense of giddiness and nausea, and a feeling of approaching unconsciousness. This is but temporary, and reaction or return to the physiological condition

[1] For a résumé of this subject see article on Collapse in Holmes's System of Surgery, American edition, Phila., 1881.

quickly occurs. When severe shock is present there is great depression exhibited by muscular relaxation, pallid and shrunken features, a languid and bewildered expression, clammy sweating, a frequent and perhaps intermittent pulse which sometimes it is said may be slow, shallow and gasping respiration, a lowered bodily temperature varying from one-third of a degree to two or three degrees below normal, and nausea and vomiting.

Usually the mind is clear or at most only slightly affected by aberrations of the special senses. The tranquil mental condition of patients suffering from profound shock due to grave railroad mutilations is often very distressing to the observer. If these symptoms of shock continue the patient dies, usually before inflammatory processes begin at the seat of injury, from cardiac failure.

In sudden death the heart may be spasmodically contracted, but oftener perhaps, the right cavities and venous trunks are engorged with blood.

Recovery from shock takes place by the depression stage being followed by reaction, which is evidenced by increasing power and slowing of the pulse, by a healthier hue of skin, a rise in temperature, and a disposition on the part of the patient to change his posture. Reaction may be inordinate and pass across the health line to the domain of constitutional over-action when symptoms akin to asthenic inflammatory fever occur. It is usually preferable, however, to have an excess rather than a deficiency of reaction, since it is easier to control force than to create it; but the condition of excitability, coupled with prostration, must not be mistaken for excessive reaction. The time at which reaction occurs depends on the nature of the injury and the recuperative force of the individual, and varies from minutes to hours.

The degree of shock varies with the severity of the injury and the impressibility of the patient. The greater the extent of the injury and the more important the structures involved, the more profound in a given patient will be the shock. On the other hand, however, we find that an impressible person will show great shock upon the receipt of a trivial wound, while a much more serious lesion in another man will be accompanied by little shock.

Shock is greater in injuries of the trunk than of the extremities, and in wounds of the abdomen than in those of the chest. In estimating the degree of shock and in diagnosticating the condition itself the surgeon must remember that direct injury to nerve centres, hemorrhage, fat embolism, rapid septicæmia, and abstraction of heat from internal viscera, and fright are liable to simulate or increase the symptoms of shock. The heart and kidneys should always be examined prior to operations, because chronic disease of these organs increases the severity of the shock of operation.

The pathological condition causing the symptoms termed shock lies in the sympathetic nervous system, and is probably a paralysis of the vaso-motor centres. The perturbation of the vaso-motor nerves produces a spasmodic contraction of the minute bloodvessels, and then lowered temperature, pallor and the concomitant symptoms are exhibited.

Treatment.—The treatment of shock will be discussed here, because in severe injuries the surgeon's attention is directed to this condition before local measures for the cure of the wound are adopted. I shall then recur to the subject of wounds and consider the modes of healing and the treatment of the different classes of wounds.

If the symptoms are slight a drink of water and fanning the face are

sufficient treatment. In severe shock perfect quiet of mind and body in the recumbent position and heat to keep up the bodily temperature are the most important requisites. Cardiac stimulants and food are then demanded in the majority of cases. Venesection, recommended by some authors because of the occasional engorgement of the veins and right heart, is probably never required. The distention of the hollow organs occurs from the vaso-motor nervous disturbance causing paralysis and is a result, not a cause of the shock. Heat and artificial respiration will be well calculated to distribute the blood engorging the viscera. Heat is to be maintained by warm rooms, blankets, bottles, or rubber bags filled with hot water, hot water enemas, or by the hot bath in which the temperature is raised from 98° to 110° F. A small amount (fʒ ss–fʒ ij) of stimulant in the form of brandy or whiskey, may be administered; but it should be remembered that many injured persons have been given alcoholic stimulus by the bystanders before the surgeon's arrival, or have taken it as a beverage before the accident. Overdosing with such remedies produces depression. Hence, the amount spoken of above should seldom be increased but may sometimes be repeated at the expiration of several hours. Small amounts of coffee, beef-tea, or milk also should be given at intervals, but here, as in the case of alcohol, large amounts lying unabsorbed in the stomach do harm and may induce vomiting.

The pulse is the indication to guide the attendant. If it increases in force and diminishes in rapidity reaction has begun. Time is then required; reaction from severe shock may extend over six, twelve, or twenty-four hours. The drugs employed in the management of shock are morphia (gr. $\frac{1}{4}$–$\frac{1}{2}$), tincture of digitalis (♏ xx–fʒ j), carbonate of ammonium (gr. v–xx), atropia (gr. $\frac{1}{60}$–$\frac{1}{30}$), all of which can be given hypodermatically; and quinia (gr. v–xx), best given by the mouth or rectum. Ether in half-drachm doses may be given subcutaneously. I have obtained in profound and almost hopeless shock very gratifying results, which I believe due to the hypodermatic administration of digitalis, ammonia, and alcohol.

As soon as reaction is fairly established cardiac stimulants must be stopped lest the traumatic or inflammatory fever be enhanced.

When operations are necessary after injuries inducing severe shock, the surgeon should wait, as a rule, until reaction has begun, since there is then less danger of causing dangerous depression from the shock of operation. Etherization has usually a stimulating effect and seems to combat the symptoms of shock.

The shock after operations is often excessive because the surgeon has been too slow in his operative work, has exposed the patient to cold air, has reduced his temperature by wet dressings and irrigation, or has depressed him by prolonged anæsthesia.

CHAPTER IX.

MODE OF REPAIR AND TREATMENT OF WOUNDS.

Repair of Wounds.—All wounds, large or small, open or cutaneous, incised or punctured, contused or lacerated, heal by that reparative process which I have, in the first chapter, called inflammation. In other words, what was there styled inflammation is really nature's reparative effort to reconstruct the injured tissues and limit the injurious influence of the original irritant. The processes called inflammation are efforts, often more or less futile, to restore physiological conditions. Inflammation is not a disease.

When the wound is of such a character that accurate adjustment of the several tissues can be and is accomplished, a reparative effort merely sufficient to supply a small amount of fibrine or lymph supervenes. This fibrine glues the parts together, then becomes changed into granulation tissue, and finally into connective tissue, or scar, analogous to the original structures. Thus is repaired the breach of continuity. This method of union is *union by first intention*, or fibrinous repair, and occurs when no foreign body, clotted blood or undue amount of transudation prevents accurate approximation, and when the parts are kept quiet and the patient's tissues are in a healthy condition and free from microbic infection or other irritation. By this mode are repaired subcutaneous and other aseptic wounds.

When there is a loss of substance, or an irregularity of the edges of the wound, the space or chasm due to the injury or to the destruction of the ragged edges by sloughing is gradually covered and more or less filled up with minute granular bodies of a pink color called granulations. These are formed from lymph, capillary loops and indifferent cells in the same way as the uniting band in cases of union by first intention. If the wound is kept aseptic there will be no suppuration and epithelial formation will occur when the granulation tissue has filled up or nearly filled up the cavity. In the meantime there will be a serous exudate from the surface of the granulations. It is difficult to keep pyogenic organisms away from such wounds when large and superficial suppuration is not unusual. Absolute asepsis should be attempted always.

The granulations have absorbent power and are gradually converted into a bluish-white connective tissue, called the cicatrix, which occupies the situation of the wound and assumes characteristics similar, though not identical, with the structures injured. This method is *union by second intention* or *granulation*. It is the only means by which healing of wounds can occur if union by first intention fails to take place. It is apt to occur in contused and lacerated wounds unless they are subcutaneous or have their devitalized edges trimmed off, are rendered aseptic and accurately approximated. Other varieties of healing have been described, but they are but modifications of the two here considered, which themselves are identical in pathological significance and process.

Healing by first intention is much to be preferred, because it requires

much less time, say from two to seven days, and leaves very little cicatrix. Union by granulation, or second intention, requires weeks or months, according to the size of wound or ulcer, and leaves a large scar, which often gives rise to deformity, on account of the contractile tendency of cicatricial tissue.

TREATMENT OF WOUNDS.—In the management of all wounds, there are four cardinal rules: 1. Arrest hemorrhage. 2. Render the wound aseptic by removal of all dirt and foreign bodies, as far as it is possible to do so without incurring risk. 3. Bring the parts into apposition, if the attempt does not, and will not, cause pressure and tension. 4. Assist the natural reparative process by mechanical rest and the prevention of putrefaction and suppuration.

These precepts apply to every wound, but their relative importance varies with the character of the injury. Thus, in incised wounds there is often much bleeding to be arrested, but no foreign body to be removed, while in contused and lacerated injuries there is frequently no hemorrhage, but numerous particles of foreign materials, such as shot, shreds of clothing and dirt, to be extracted.

The arrest of bleeding will be spoken of under Diseases of the Bloodvessels, and the methods of approximating and dressing wounds, and of preventing germ infection under Minor Surgery and Surgical Dressings. Hence, I shall at this point speak only of the constitutional treatment required by patients suffering from wounds. To coöperate with the processes of repair and to prevent the occurrence of retarding complications may or may not require the surgeon's interference. In aseptic wounds, union usually occurs steadily and expeditiously, and nothing is required but patience on the part of the attendant, who has dressed the wound with germ-free applications. At other times, because of the contaminated nature of the wound or because of the conditions or surroundings of the patient, sloughing, burrowing of pus, abscesses, erysipelas, or pyæmia, render the surgeon's duties responsible in the highest degree. As all wounds heal by the reparative efforts of nature, inaccurately called inflammation, the treatment detailed on previous pages, for the management of the inflammatory process is to be pursued. Hence patients showing a sthenic form of constitutional implication must be depleted and depressed by bloodletting, purging, arterial sedatives, and other measures of a kindred nature. The asthenic type, on the other hand, demands supportive treatment, which is effected by tonics, stimulants, and a generous nutritious diet.

Wounds must be treated locally according to their special characters, after the general rules given above have been followed; but, in all cases, the most rigid asepsis or antisepsis must be carried out. There is no doubt that serious complications arising in connection with wounds, whether the wounds be accidental or operative, can be mostly, if not entirely, avoided by keeping the wound-surfaces free from microörganisms. It is to these organisms, either introduced at the time of injury or allowed to come in contact with the wound at a later period, that the constitutional disturbances, slow healing, and suppuration so often found, are due. It is the surgeon's duty to avoid such microbic infection in operation wounds, and to limit it in accidental wounds when it has taken place before he had control of the patient's destiny. Death is often, and has often been, due to the surgeon's ignorance or neglect of these precautions. This subject will be further discussed, under Surgical Dressings, in the next section.

Treatment of the Different Classes of Wounds.—Contusions, being subcu-

taneous wounds, require little treatment. If there is a great deal of subcutaneous extravasation, cold water and pressure with a bandage are indicated to stop the hemorrhage. Absorption of the effused blood takes place very slowly, but gradually the black and blue appearance changes to a greenish and yellowish hue, and the discoloration then disappears. Alcohol, chloride of ammonium solution (gr. x–xx to the fluidounce), tincture of arnica and hot water are often used as external lotions, but the benefit derived from them is doubtful. They do no harm, however, and serve to satisfy the patient. Moreover, the rubbing which they encourage probably assists the vessels in taking up the effused blood. If the extravasation is very great in regions where loose connective tissue is abundant, as in the eyelids and scrotum, the swelling will be so great that the surgeon may be tempted to make incisions for its escape. This is usually bad practice, because large amounts of blood thus effused will be absorbed, while contact with the air renders access of pyogenic or putrefactive bacteria probable. When extravasation of blood and rapid inflammatory effusion of serum cause such swelling and tension that the limb becomes cold and there is danger of gangrene from interstitial pressure, long incisions *must* be made through the tense skin. The skin then retracts and relieves the pressure. These incisions must be made with antiseptic precautions, and the whole limb dressed with gauze. When absorption does not occur, but there remains a tumor filled with fluid blood for a long time, the term hæmatoma is employed. This usually requires aspiration or incision. Abscesses and serous cysts occurring subsequent to contusions demand evacuation.

The treatment of open contused wounds and of lacerations may be considered together, because the same principles govern their surgical management. Such wounds are nearly always infected with germs, from contact with the vulnerating body or from their surroundings at the time of their infliction. Before the wounds are dressed, it is very necessary to render them aseptic. This is done by the removal of all particles of dirt with aseptic forceps or fingers, and by cleaning and disinfecting the wounds by means of irrigation with antiseptic solutions. Corrosive sublimate solution (1 : 500 or 1 : 1000), poured upon and into the wound from a pitcher or a syringe or squeezed from a sponge, is one of the most effective of such agents. Betanaphthol and other substances may be employed. All accidental wounds must be thoroughly sterilized in this manner in order to avoid the occurrence of suppuration. In large wounds where such a procedure would give pain, it is not only justifiable, but it is requisite, to give ether in order that this important procedure may not be omitted. It is good surgery, after having etherized the patient, to scrape and scrub such wounds thoroughly with a nail-brush and soap-suds before using the antiseptic solution. This double proceeding removes or destroys all germs that may exist in the wound. Injuries received from machinery almost always need such treatment, because of the dirt and grease ground into the tissues at the time of the accident, or upon the patient's skin before the receipt of injury. After such wounds have been made germ-free, they should be sutured as operative wounds, and provision made by catgut strands or drainage-tubes for the escape of serous and other fluids which may exude. The conversion of such accidental wounds into aseptic wounds by these measures is an essential first step in treatment. Wounds subjected thoroughly to this treatment usually unite by first intention. If this is not the case the granulation process goes on so rapidly that the patient's convalescence is com-

paratively short. In former times it was considered impossible for such wounds to heal without suppuration, which was accompanied in many instances by more or less violent constitutional implication. We now know that the wounds were, in those days, really complicated by infection from pyogenic and putrefactive germs.

After thorough cleansing with sublimate or betanaphthol solution, and after all foreign bodies have been picked out with sterilized forceps, the bruised and lacerated parts should be adjusted and kept in place by sutures, if this can be done without causing tension or interfering with the escape of the fluids to be subsequently secreted. Much damage is often done by making nice approximation of such wounds and providing no escape by drainage-tubes and counter openings for the serum and pus which may arise in a few hours and cause tension and pain. If the fluids thus secreted find no free avenue of escape, burrowing of pus and septic conditions are liable to occur. Parts that cannot readily be brought together should be allowed to gape.

Union by granulation is the method of healing in these wounds. Contused and lacerated wounds are usually followed by sloughing of their ragged borders; but it is improper to cut away anything more than the edges at the first dressing, since it is not possible to determine what parts are actually devitalized. The ordinary gauze dressing should be used. Thorough drainage of deep and irregular wounds by tubes, strings of rubber, or horsehair, is important. When the sloughing stage has given place to the granulation stage the resulting ulcerated surface is treated as an ulcer. If abscesses are liable to form, provision must be made for draining the deep parts by drainage-tubes, incisions, and washing out with syringes or by hydrostatic pressure.

When the injury has caused complete devitalization, amputation must be done as soon as reaction from shock has occurred. If the soft parts are completely stripped from the bones amputation may be demanded, even when the osseous tissues are intact, because of the danger of acute traumatic gangrene. If attempts have been made to preserve crushed limbs and rapidly spreading gangrene supervenes, amputation is usually to be done promptly at a high point of the limb.

In incised wounds an attempt should always be made to secure union by first intention, because thus time is saved, the scar is less disfiguring, there is no drain from the system as when suppuration occurs, and there is less chance for septic complications. If the effort fails union occurs by granulation, as in lacerated wounds. In lacerated and contused wounds union by first intention is, from the nature of the injury, almost impossible. After arrest of hemorrhage, removal of foreign matters, and the production of an aseptic condition in incised wounds, accurate adjustment is to be obtained by sutures of catgut, silk, or wire; or in small wounds by a layer of gauze or absorbent cotton glued to the skin by collodion. About the face the latter dressing is sometimes preferable because a scar is left by sutures. The transparent gauze allows the surgeon to see that the wound is evenly apposed, and any unexpected serous or purulent discharge soon leaks through the meshes of the tarletan and is not shut in by the dressing. In other places than the face I prefer sutures, because even deep wounds can be apposed along their entire surfaces by buried catgut sutures applied to each successive layer of tissue. There is no objection to the minute points of scarring from sutures except on the face. I always use sutures for the scalp. The application of interrupted and twisted sutures and of the collodion gauze dressing will be described in

the chapter on Minor Surgery. I will merely repeat at this point the caution to students that there is a tendency to apply sutures too tightly. Mere approximation of the edges of the wound is what is desired. Any marked puckering is a serious fault. Catgut sutures stretch a little after tying and can be drawn tighter than wire ones.

Punctured wounds when made with a sharp instrument require treatment like incised wounds; when made with dull instruments, such as carpenter's nails, they are practically lacerations. If they are penetrating wounds there will probably arise inflammation of the lining membrane or viscera of the cavity opened. This will demand treatment directed to the special lesion. The removal of the foreign body is often difficult in the case of punctures. If withdrawal with forceps is impossible a free incision will be required, especially if the vulnerating body is buried in the tissues and invisible. This should usually be done at once, and particularly when the foreign body was probably covered with dirt and is especially liable to cause septic infection. The incision adds little or nothing to the gravity of the injury, may result in detection of the foreign body, and even if unavailing gives free drainage and lessens the dangers of erysipelas and other complications frequent in punctured wounds. A simple or an electromagnet has been found serviceable at times in removing chips of iron after lacerations or punctures of the eyeball. It is almost impossible to render a punctured wound aseptic without enlarging it; hence it is often good policy to increase it in order to sterilize it and prevent the occurrence of cellulitis or gangrene.

Poisoned Wounds are usually punctures, since stings of insects, fangs of reptiles, and points of knives are usually the vulnerating instruments. Any form of abrasion or wound of the skin may be inoculated, however, and at times simple maceration of the skin with poisonous fluids in locations where the integument is thin is sufficient.

The wounds made by insects are comparatively unimportant in this country. It need only be said that if the sting remains in the wound it should be extracted, and lead water, sublimate solution (1 : 1000), water of ammonia, or spirit of camphor applied. Bites from insects with poisonous saliva should be managed in the same way. Any subsequent inflammation should be treated on general principles.

Venomous snake-bites are usually accompanied by rapid and multiple interstitial hemorrhage, caused by an interference with the coagulability of the blood and disintegration of the vessel walls, due to the poison; paralysis of respiration and the spinal centres; and locally great swelling and vesication. The profound prostration or collapse is accompanied, however, with unimpaired intellection. Death occurs in an hour or so if the amount of poison is large, but in other cases may be delayed several days and occur through the depressing influences of gangrene and suppuration. Many constitutional remedies have been vaunted, but there is no positive evidence in favor of any except alcohol, which should be given freely, but not indiscriminately. The intravenous injection of ammonia has been recommended, but its value is not yet established. The local treatment is important, and consists in *immediate* free excision of the wound and surrounding tissues, the application of a tight ligature to the limb above the wound to prevent venous and lymphatic absorption, sucking or cupping the wound left by the knife to extract the poison, and cauterization with equal parts of carbolic acid and alcohol.

Permanganate of potash freely injected into the wound and surrounding tissues is serviceable in destroying the poison and should always be

used if obtainable. Nitrate of silver is valueless as a caustic, as, indeed, it always is when a tissue-destroyer is desired. The so-called intermittent ligature is a rational measure. It is merely a tightly constricting band, applied at the cardiac side of the wound and relaxed momentarily at intervals in order to allow the poison to enter the general circulation slowly and in divided amounts. This gives the surgeon a better opportunity to counteract the effects of the poison and obtain its elimination than when the venomous material is suddenly absorbed in full amount. The poison is a chemical, not a microbic, one. It contains, according to Mitchell and Reichert, two albuminous poisons, called by them venom peptone and venom globulin. With the venom are introduced into the wound many bacteria, which are the agents and causes of the putrefaction which so rapidly occurs after snake-bites.

Inoculation with the fluids of diseased or of decomposing animal tissue at times causes serious poisoned wounds. Malignant pustule, or charbon, contracted from cattle suffering with murrain, and glanders, or equina due to inoculation or infection from horses having this affection, are the most important forms derived from the lower animals. These affections are due to microörganisms and the ptomaïnes developed by their growth. I omit the discussion of hydrophobia here, because all pathologists are not agreed as to its being due to inoculation. It will be considered under Diseases of the Nervous System.

Malignant pustule is especially found in tanners and butchers and is characterized by a vesicle at the point of inoculation, which is soon followed by violent inflammatory complications, such as angeioleucitis, cellulitis, and gangrene. The degree of asthenia accompanying this carbuncular inflammation is profound and shown by its usual symptoms. The affection is due to the presence of a vegetable organism, the anthrax bacillus, contained in the blood and other fluids. The treatment consists of excision, or free incision, followed by thorough cauterization with corrosive sublimate or carbolic acid. Saturating the cellular tissues with injections of iodine has been considered valuable. Stimulant, supportive, and anodyne remedies internally administered are required. Free incision through the swollen and infiltrated tissues involved are indicated, even after the early stages.

Glanders is another infective or mycotic disease, and is characterized by asthenia and by multiple indurations and ulcers of the surface, inflammation and suppuration of the salivary glands, and profuse nasal discharge; though the last symptom is not always prominent in the disease in man. The treatment should be conducted on general principles, as there is no special remedy for the condition.

The prognosis in malignant pustule and glanders is unfavorable in the majority of cases.

The term dissection wound is applied to injuries received during operations on dead, and sometimes on living, bodies. They occur also in butchers, fish-dealers, and others whose occupation causes them to handle dead animals. Many wounds so received act merely as similar injuries inflicted under other circumstances; sometimes there is an additional amount of inflammation, as if the animal fluids irritated the part; but occasionally a most virulent form of local inflammation occurs, and is accompanied by grave constitutional symptoms of blood infection. Persons whose previous health is poor suffer more frequently from such wounds than do other persons whose tissues have more resistence to infectious influences. These disastrous symptoms appear to be due to a

specific poison generated in the cadaver a short time after death, or perhaps before death, which seems to be destroyed by the advent of marked decomposition. Cases of death from peritonitis, erysipelas, and pyæmia are more likely than others to cause such dissection wounds. These wounds owe their virulence to microörganisms or the chemical products of such organisms. They are, in fact, septic wounds.

There is a complete, or almost complete, protection afforded by preserving cadavers with zinc chloride, as is done in our Philadelphia dissecting-rooms. It is important to recollect that the poison appears at times to infect the pathologist, who is making an autopsy, through the hair-follicles and unbroken skin of the hands, especially if they are immersed in the fluids of pyæmic pleuritis or peritonitis.

The symptoms of a dissection wound, if of the ordinary variety, are those of an acute inflammation about a wound—viz., pain, swelling, inflamed lymphatic glands, fever, etc. Quite frequently suppuration occurs. In the more serious form a vesicle appears, after the lapse of a couple of days, at the point of puncture, and is followed by erysipelatous inflammation, angeioleucitis, rapid involvement of the cellular tissue, suppuration, sloughing, and septic symptoms, as shown by rigors, fever, colliquative sweating, and rapid prostration of the vital powers. Those cases seem to be worse in which inflammation of the lymphatic glands occurs before active inflammation of the wound.

The treatment consists in ligation above the wound to prevent absorption, excision and cupping to get rid of the virus, and cauterization, probably best effected by zinc chloride, corrosive sublimate, or carbolic acid. If, however, septic symptoms occur in spite of these precautions, quinia, alcoholic stimulus, anodynes, nutritious food, and supportive agents must be given and the wound treated by incisions and antiseptic washes. It s said that the spreading inflammation may at times be arrested by a blister applied around the limb, above the wound, as soon as the red lines indicating inflammation of the lymphatic vessels appear. Smearing the surface freely with mercurial ointment is often beneficial in these and other cases of angeioleucitis and phlebitis.

Gunshot Wounds.—Gunshot wounds are injuries produced by the explosive force of gunpowder confined in firearms. They may, therefore, be caused by the powder alone, by the projectiles discharged, by pieces of clothing or splinters of wood given motion by such missiles, and by portions of weapons shattered by explosion. Gunshot wounds partake of the nature of contused and lacerated wounds, and hence are often followed by sloughing. When fractures are produced they are almost invariably open, or compound and comminuted. Cannon balls crush and pulpefy the parts struck. The wind caused by a passing ball does not and cannot produce a contusion, as was formerly supposed. In injuries so attributed the elastic skin has escaped injury, though actually struck.

The wound made as the missile enters the tissues is called the wound of entrance, that made as it leaves the part, after traversing it, is termed the wound of exit. The wounds of entrance and exit, especially if made by a projectile travelling with a comparatively moderate velocity, differ in appearance. The former is small and has depressed and regular edges, stained, perhaps, with grease and powder. The wound of exit has everted, ragged margins, not stained, and is much larger than that of entrance, because the skin has no external support when it receives the impact from within. Conical bullets discharged by rifled arms travel with such velocity that these distinctions are not always present.

A bullet may traverse the tissues in a direct line, be deflected by bones or fascias, or be split against a bone and make several openings of exit. Instances are recorded where the bullet has taken a circular course and been found imbedded near the wound of entrance. Portions of clothing or wadding carried into the wound act as complications. Small shot fired at short range, say a foot or two, will make a single wound of entrance because there has been no scattering. Powder alone may, if discharged near the skin, produce a serious injury. In any event, if unburnt powder enters the skin there will be permanent discoloration like tattooing, unless the grains are discharged by suppuration or removed by the surgeon.

It is unnecessary to speak here of shock, hemorrhage, and the other symptoms of gunshot wounds, since they correspond with injuries of similar gravity produced by other vulnerating agents.

The treatment consists in removing the foreign body as soon as reaction is established, provided it can be done without seriously increasing the danger. The injury has been produced by the entrance of the projectile, and its passive residence in the tissues does not do sufficient harm to permit great risks to be taken for its removal. Bullets, especially if smooth, often become encysted and may remain many years without causing trouble. Still, the extraction of the ball, fragments of wadding or clothing, and splinters of bone hastens the cure by lessening the danger of septic inflammation and suppuration, and at the same time gets rid of the possibility of remote inconvenience from encysted bodies. Hence, the bullet should be extracted, if it can be done either through the opening of entrance, which seldom is possible, or by a counter-incision. Of course if the wound of exit proves the escape of the entire bullet, and no foreign material lies in the wound, these measures are unnecessary. The wound should be made aseptic by cleansing, by irrigation with sublimate or betanaphthol solution, by counter-openings and drainage, and should be dressed with antiseptic gauze.

Gunshot wounds, in which nothing except the bullet has entered the tissues, are often aseptic, probably because the missile has been sterilized by the heat generated in its flight. Much harm is often done by infecting such aseptic wounds by means of probes and fingers. Unless the examination is aseptically performed, it had better be omitted, and the wound dressed with antiseptic gauze until a proper examination in skilled hands is obtained.

To determine the course and position of the ball careful probing with an aseptic finger or metal probe is proper. When the opening involves the abdominal, cranial, or thoracic cavity, it is usually justifiable to make a free incision under rigid asepsis and explore the contained organs. This important topic will be discussed under injuries of the brain and viscera. In abdominal wounds immediate exploratory operation is usually demanded. In cranial and thoracic wounds delay in or abstinence from operation may be proper.

It is always well to examine the surface of the body on the opposite side, for the projectile may have passed across and be lodged under the skin, whence an incision will liberate it. For probing or examining the wound the patient should be placed in the position occupied when shot, to get the muscles and bones in the same mutual relation. The probe should be slightly bent at the tip to enable it to follow tortuous passages more readily as it is delicately inserted and turned about in the hand of the surgeon. The probe of Nélaton, which has a roughened porcelain

tip, may be serviceable, because it becomes marked by contact with the leaden ball and thus shows that the hard mass touched is not bone. The electrical apparatuses for determining the location of bullets are practically valueless. When the ball has been found, attempts at extraction are to be made with the various forms of bullet-forceps and extractors. The incision may be freely enlarged if necessary. Unburnt powder about the face and hands is to be removed by patient picking with a small knife, or by cutting out little disks of skin with an instrument like a punch.

Another method is to prick the skin with a needle dipped in croton oil or other irritant, which causes suppuration and leaves only minute white scars instead of the blue powder marks.

When extraction has been accomplished or the attempt found fruitless, the wound is to be managed on the general antiseptic principles previously discussed. Thorough drainage by tubes or counter-incisions is resorted to according to indications. Immobilization with gypsum bandages over the antiseptic dressings will aid in protecting the injured bones from undue motion, if gunshot fracture exists. Amputation may be required for gunshot injury if the bones are greatly shattered, large vessels or nerve-trunks destroyed, joints freely exposed with comminution of bones, or if rapidly spreading mortification is threatened. Primary amputations are usually preferable in such cases to secondary operations.

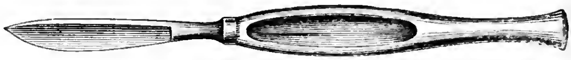
Excision may at times be available in joint injuries or in gunshot fractures of the shafts of long bones.

CHAPTER X.

PRACTICAL SURGERY AND ANÆSTHESIA.

INSTRUMENTS.—The instruments of the surgeon are innumerable, but those ordinarily required are few in number and simple in construction. Knives, forceps, scissors, hemostatic forceps, saws, needles, probes, and grooved directors are indispensable for the performance of surgical operations, and undergo many modifications for special purposes. Certain operations demand additional instruments of peculiar character, such as the trocar, catheter, and syringe. A knife with a markedly convex or bellied edge is technically called a scalpel, while one that has very little belly and is nearly straight is termed a bistoury.

FIG. 38.



Scalpel with aseptic hollow metal handle.

Scalpels are usually too convex, and are satisfactory only when a large flap of skin is to be dissected up. A knife nearly straight, partaking, therefore, of the character of the bistoury, is the best form and answers equally well for incisions, dissections, and opening abscesses by transfixion.

FIG. 39.

Bistoury with aseptic hollow metal handle.

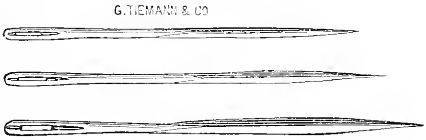
The edge of a knife is tested by drawing it from heel to point across the free border of a finger nail, for by this manœuvre any notches will be apparent. Its keenness is proved by the ease with which it will cut when the edge is gently pressed upon the skin of the finger. The sharpness of the point is tested by the thrusting it through a piece of kid or gold-beaters' skin stretched tightly over a ring. This little drum gives out a distinct sound at the time of puncture if the point of the knife is dull.

Hemostatic forceps have a lock and are used to compress wounded vessels during the various steps of an operation, so that the surgeon need not be delayed by ligating bleeding points. In truth this temporary compression is often all that is needed; for small vessels soon become permanently sealed and when the forceps are removed require no ligature. Large vessels should be tied before the hemostats are removed.

Straight needles with the point ground on three sides, such as are used by glovers, are nearly always preferable to those curved near the point.

They penetrate the tough skin more readily and enable the surgeon to direct the point more certainly.

FIG. 40.

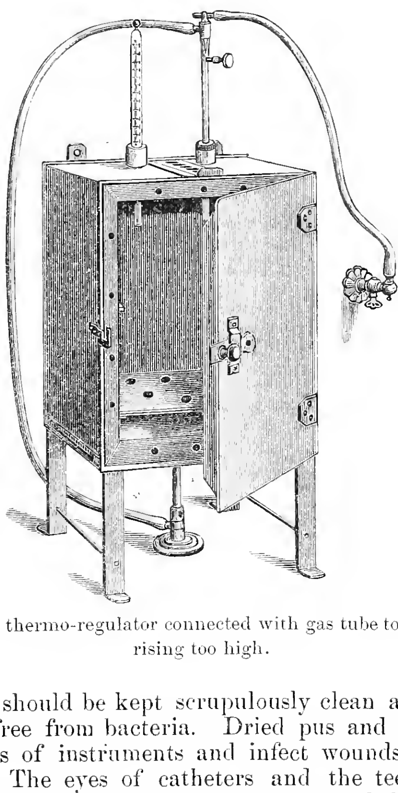


Glover's or bayonet-point needles, enlarged.

A needle fixed in a handle and having an eye in the point is often useful.

The sharp hook employed for drawing out the ends of divided vessels is called a tenaculum. It has been supplanted to a great extent by the hemostatic forceps. Probes should always be firm, but sufficiently flexible to allow the operator to bend the end slightly before beginning to explore a sinus. The slightly curved extremity will follow more readily the tortuosities of the channel, when the probe is rotated in the fingers.

FIG. 41.

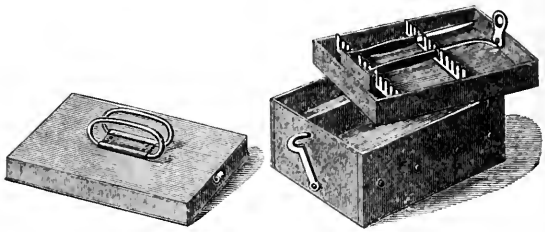


Sterilizing oven with thermo-regulator connected with gas tube to prevent temperature rising too high.

All instruments should be kept scrupulously clean and protected from dust, so as to be free from bacteria. Dried pus and blood are liable to remain in crevices of instruments and infect wounds with which they come in contact. The eyes of catheters and the teeth of forceps are very frequently allowed to contain foul material of this character. Ordinary dust usually contains germs, and if in these fissures, may infect

a wound. Moist or dry heat is the only perfect sterilizer of instruments. They should always be washed perfectly clean after operation. Just before use they should be heated to at least 212° F. and kept at that temperature for ten or fifteen minutes. This may be done by boiling in water, by steam, or by baking in an oven. The handles should be smooth and of metal and not cemented, since cemented instruments are damaged by heat. All unnecessary complications and crevices should be avoided. Copper boxes with dust-tight lids are convenient receptacles in which to keep, bake, and transport instruments.

FIG. 42.



Copper boxes for sterilizing instruments by baking.

INCISIONS.—The knife should always be held delicately though firmly. The most common position of the knife for making incisions is that assumed when one uses a pen, though in dissecting up large flaps the surgeon will often hold the knife as if it were a fiddle-bow. Occasionally, as in amputations, the large handle is firmly grasped with the entire hand. When an incision is to be made the fingers of the left hand should support the skin at the point where the knife is to be entered, the surgeon then thrusts the point into the tissues perpendicularly and, immediately depressing the handle of the knife, cuts with the edge until the incision is sufficiently long; he should then, in order that the tissues may all be completely divided to the very end of the incision, elevate the handle and bring the knife out perpendicularly.

Incisions should be sufficiently large to expose the parts and should be made with decided strokes of the knife. Nothing discloses the inefficient surgeon so much as small button-hole like incisions, made by picking with the point of the knife. When possible, incisions about the face should follow the cutaneous creases that the scars may be as unnoticeable as possible. Oblique division of the skin causes slight scarring, and curvilinear incisions are less noticeable than straight ones. In making incisions over large vessels or important organs the grooved director is to be pushed under the successive layers of tissue before the knife is used to divide them. This does not apply to the skin incision.

ANÆSTHESIA.

For trivial operations, such as opening abscesses and removing small tumors, local anæsthesia is sufficient. It is induced in one or two minutes by applying a lump of ice or a mixture of ice and salt to the skin; by blowing ether, rhigolene, or other refrigerating vapor upon the surface with an atomizer, or by employing cocaine hydrochlorate.

Local anæsthesia obtained by the use of aqueous solution of hydrochlorate of cocaine is eminently satisfactory. A twenty grain solution of this salt in water painted upon a mucous membrane with a camel's-hair pencil, or dropped upon it from a medicine dropper, will produce local anæsthesia in about three minutes and will permit the performance of any minor operation without giving the patient pain. If the application first made does not produce insensibility to pain in the part to which it is applied, a repeated application may be made in a similar manner. The anæsthesia thus produced lasts a number of minutes. It is important that the part to which the anæsthetic is applied should not be alkaline in reaction, since alkalinity of the surface interferes with the anæsthetic power of cocaine.

Local anæsthesia cannot be produced in the skin, as in mucous membranes, by merely painting or brushing the surface with the solution, except for operations made upon very thin skin, as that of the eyelids. For cutaneous operations of a superficial character it is sufficient to inject the cocaine into or under the skin by a hypodermic syringe. From five to twenty minims should be introduced by one or two punctures. If more perfect local anæsthesia is desired, as for the removal of small tumors, the solution can often be incarcerated in the part, into which it has been injected, by retarding the venous return from the cocainized area by means of a ligature or a rubber ring. If an operation is to be made upon a finger or upon the penis, for example, the anæsthetic will last longer and prove more effective if it is incarcerated at the seat of operation by tying a piece of tape or placing a rubber band around the base of the member before the hypodermic injection. If an operation is to be made upon the eyelids or upon very thin skin, but not at a very great depth, a sufficient degree of painlessness can be obtained by simply painting the thin skin with the solution in very much the same manner as is done in operations on mucous membrane. In all such instances the surface should not be alkaline, else the anæsthetic power of the drug will not be exerted.

It must be remembered that death has occurred from cocoaine poisoning. It is best, therefore, to avoid the toxic affect by not using a solution stronger than twenty grains to the ounce, and it is wise seldom to use more than twenty minims at the most, unless the drug has been incarcerated. Then after operating the surgeon can by intermittent relaxation allow it to enter the system gradually. The passage of urethral bougies and instruments of a similar character may be rendered quite painless by injecting the urethra with cocaine. When used upon the eye in large quantity and in too strong solution it occasions opacity, temporary however, of the cornea, and may, therefore, possibly do harm if it is not used with proper caution.

For the production of general anæsthesia in surgery ether is preferable to any other agent at present generally employed. Chloroform is much more dangerous. This is a sufficient cause for the abolition of its use. Its claimed advantages over ether are considerably overrated because of the improper methods in which ether is often given.

Nitrous oxide is not a good anæsthetic for protracted operations, requires bulky apparatus for its administration, and in short operations can readily be substituted by local anæsthesia or the primary anæsthesia of ether.

Rapidly repeated deep inspirations continued for a minute or so will produce insensibility to pain (analgesia) for slight operations, though the sensibility to contact is not obliterated. This effect may be utilized in

surgery, but it and anæsthesia from nitrous oxide are used very little outside of dentistry.

Before etherizing a patient the surgeon should examine the kidneys, heart, and lungs. The presence of disease in one or all of these organs should not deter one from the administration of ether when necessary for a painful operation; but the knowledge of its existence renders one exceedingly cautious, and protects him against the verdict of carelessness in the event of dangerous symptoms or a fatal result.

Anæsthesia is always a dangerous condition, and requires the undivided attention of an experienced assistant. Death has occurred not infrequently from etherization and often from chloroform anæsthesia.

The patient's stomach should be empty, lest vomiting occur during or after anæsthesia. Hence, he should fast for four or six hours prior to etherization, and it is even better if no *solid* food has been taken since the previous day. A hypodermic injection of morphia (gr. $\frac{1}{6}$ to gr. $\frac{1}{4}$) and atropia (gr. $\frac{1}{120}$ to gr. $\frac{1}{60}$) should be administered about fifteen minutes before inhalation is begun. This renders anæsthesia quieter, more rapid, and more safe. It is not an absolute essential but is very judicious. All clothing restricting deep inspiration must be removed or loosened. It is important to insist upon women unfastening their corsets and the skirts tied about the waist. Do not trust to the assertion that their clothes are not tight. False teeth and pieces of tobacco must be removed from the mouth, because of the danger of their falling backward into the fauces and obstructing respiration. The patient is usually placed in the recumbent position, unless the operation is about the mouth or nose, when the semi-recumbent posture is better, as it prevents the blood flowing back into the pharynx. The semi-recumbent or sitting posture is not justifiable during chloroform inhalation. In operations upon the nose and palate it is often better to have the patient lying on his back with the head so bent backward that the palate is lower than the floor of the mouth. Blood is thus kept away from the site of operation and yet does not flow into the larynx, causing choking and coughing. When these preliminaries have been arranged the patient is shown how to inspire and expire deeply, and is encouraged to do so for a few moments. I sometimes tranquillize my patients and teach them to breathe properly by placing the dry towel over the face for a few seconds before adding ether.

No inhaling apparatus is required. A cone of paper containing a loosely folded towel is a very satisfactory contrivance; but a small napkin or a handkerchief loosely folded and covered by a large towel so that the ether vapor cannot escape is usually preferable. The outer towel should cover the eyes of the patient, and no talking on the part of the bystanders should be allowed until insensibility occurs. The senses of sight and hearing should not be stimulated by any such disturbing influences. The ether vapor must be given in a concentrated form, and from one to two fluidounces should be poured on the napkin at first, that renewal may not often be required. When inhalation has once fairly begun the ether cloth should never be removed from the face, unless spasm of respiration or actual vomiting necessitates its temporary withdrawal. It should be held closely to the nose and mouth; sufficient air will reach the lungs through the meshes and folds of the towel. The patient becomes excited, the surgeon irritated, and the stage of etherization greatly prolonged by the etherizer allowing a large amount of air to mix with the anæsthetic vapor. Frequently, indeed, I have seen the cloth taken entirely away from the face while additional ether was being poured on

the napkin. This is mismanagement, for it allows the stage of excitement to be prolonged, and condemns the patient to a protracted anæsthesia which increases the danger of subsequent bronchial irritation and cardiac depression. If the room is kept quiet, the patient previously taught how to breathe deeply, a full amount of ether poured on the towel, the eyes of the patient covered, and no air admitted to the lungs except that which passes through the towel, complete anæsthesia can be obtained in from three to ten minutes in nearly every instance. *It is not safe to give chloroform in this manner.*

During the entire period of etherization the administrator must carefully watch the respiration, color of skin, and pulse. The first two points demand especial scrutiny, but the changes in cardiac force, which can be most conveniently investigated at the temporal artery in front of the ear, must not escape examination.

It occasionally happens that after a few inhalations have been taken a spasm of respiration takes place, evinced by absence of inspiratory effort and cyanosis of the face. This calls for the withdrawal of the ether for a moment, when a deep inspiration occurs, and no further symptoms of asphyxia are shown. If in the stage of excitation the patient struggles and cries out, the ether cloth must be kept closely applied, because access of air increases the excitement. The crying and shouting are desirable at times, because by the deep inspirations necessitated inhalation is more quickly accomplished. Retching as if vomiting was about to occur is an indication to keep up the ether. During complete anæsthesia vomiting does not take place. If, however, the stomach contents are regurgitated upward into the pharynx and mouth, the ether must be stopped until the fauces are cleared of materials that might pass into the larynx. The suspension of inhalation should be as momentary as possible. Sometimes the ether vapor causes an abundant secretion of bronchial mucus, which collects in the larynx and fauces and causes impeded respiration. This complication is met by clearing the throat with a finger introduced into the mouth, or by turning the patient on his face for a moment with his head hanging down over the edge of the operating-table.

When the conjunctiva is insensible to touch with the finger, the muscular relaxation complete, and a tendency to stertorous breathing noticeable, the time for operating has arrived. The ether may then be withdrawn or only administered in sufficient quantities to keep up the anæsthetic state without inducing a continuance of loud palatal and laryngeal stertor. Stertorous respiration usually means that anæsthesia should not be pushed, since the patient is then insensible to pain.

There is a primary anæsthesia lasting about a minute which is associated with muscular relaxation and occurs soon after inhalation has begun. This stage of etherization may be utilized for the performance of such operations as opening abscesses and extracting teeth. The recovery from this anæsthetic condition is very prompt and unattended with the nausea and other after-effects of prolonged etherization. This primary anæsthesia or first insensibility of ether is not sufficient for other than minor surgical operations. It resembles to my mind the analgesic effects of rapid respiration, previously mentioned, more than true anæsthesia.

In all administrations of ether it must be remembered that its vapor is inflammable and so dense that it falls toward the floor; therefore all candles or other lights should be placed at a distance from the patient and at a higher level than the operating table.

When patients regain consciousness after etherization they occasionally

become very noisy and hysterical. The shouting can be stopped by pouring a little water into the mouth every time the patient opens it to cry out. This compels him to close his mouth to swallow. If the nostrils are closed by one hand of the attendant while the other hand administers frequent doses of water, the patient soon becomes too much occupied with swallowing and mouth breathing to think of making further outcry. If dangerous symptoms, such as asphyxia, or cardiac failure, occur during the administration of an anæsthetic the inhalation must at once be suspended. If mucus or vomited matters produce interference with respiration they must be promptly removed. Tracheotomy might be demanded when ankylosis of the jaws or other causes interfered with proper clearance of the larynx. Imperfect respiration may be due to an effect of the ether on the nerve-centres. Pulling the tip of the tongue forward and far out of the mouth often aids the respiratory function, but artificial respiration and electrical stimulus may occasionally be required. In many cases dashing cold water in the face, slapping the cheeks with a towel dipped in water, or pouring a little ether upon the epigastrium is sufficient. Pushing the lower jaw upward and forward has been recommended as a valuable procedure.

Heart failure producing anæmia of the brain is combated by inversion of the body, perfect muscular quiescence, and inhalations of nitrite of amyl. In addition atropia, digitalis, and perhaps ammonia should be given hypodermically in full doses to combat the toxic effects of ether. Experimental investigation in physiological laboratories seems to prove that alcohol is injudicious in the treatment of ether poisoning. It should, therefore, not be given in such cases. If this experimental evidence is accepted it is improper to administer alcohol before etherization to avert shock. Quinine, atropia, digitalis, and morphia are preferable.

Persons addicted to alcoholic stimulation require more ether to induce profound anæsthesia than temperate ones, because they have become habituated to the effects of similar intoxicating agents. The administration of the anæsthetic must be cautious, because the viscera of drunkards are frequently diseased.

It is unwise to etherize a patient without assistance, because dangerous symptoms might arise from the anæsthetic or the operation, and the surgeon would be unable to give efficient aid alone. A woman should never be etherized by a man unless a third person is present, since a charge of criminal assault might be made because of erotic dreams during the anæsthetic state.

CHAPTER XI.

OPERATIVE SURGERY.

PREPARATION OF THE PATIENT AND THE SURGEON AND MODE OF CONDUCTING OPERATIONS.

THE preparatory treatment of persons about to undergo operations that do not require immediate execution is important. Debilitated patients should be built up by food and tonic regimen; those of an opposite constitution may require more moderate diet than usual, purgation, and some restriction as to stimulants.

Peculiarities of disposition and constitution should be studied by the surgeon, since the existence of the hemorrhagic diathesis, a tendency to delirium or any other marked habit of body might influence the choice of methods of operating. Encouraging words are of great value in sustaining the spirits of timid patients. All patients, if placed in a hospital or removed from their homes, should ordinarily be allowed a day's delay in order to become accustomed to strange surroundings, nurses, beds, etc. If restraint of a limb in one position is essential to the success of an operation, it is well to keep the limb in that abnormal posture for a day or two that the weariness so caused may pass away. Menstruation if normal does not seem much of a contra-indication to operation, though the time between the periods should ordinarily be selected. Pregnancy is usually a proper cause of delay in operations of expediency. The seat of operation must always be rendered aseptic by shaving, so as to remove the fine hairs which may retain dust and germs, and by subsequent thorough scrubbing of the skin with soap and water. A second washing with a sublimate solution (1 : 1000) is then proper. Before serious operations the patient should, if possible, be given in addition a full bath the evening previous. This is to avoid septic contamination from bacteria on the skin. The umbilicus and the folds of the skin about the groins, axillæ, and toes are especially apt to be overlooked in these cleansing processes. The secretions, epidermis, and dirt retained there are full of bacteria, as are the spaces underneath the nails of the patient as well as of the surgeon.

A good light and a bright, cheerful day are important factors in securing the best conditions for operative surgery. A patient should never be kept waiting by the surgeon after the appointed hour. Anxiety and suspense induce nervousness. I always endeavor to arrive before the time agreed upon so as to anticipate the worrying period.

It becomes necessary at this point to enter with more detail into the matter of asepsis and antisepsis.

By asepsis is meant absence of all vegetable parasites or microörganisms. The word, therefore, is employed to signify that the surgeon has used every effort to prevent the presence of any such organisms in the wound; and implies, therefore, the absence of such parasites from the surgeon's

hands, from the instruments used, from the dressings applied and from the surroundings. Asepsis then, or aseptic surgery, means that the procedure is germ free.

By antisepsis is meant that the manipulations are directed toward the destruction of all microörganisms which may be present. In the one case the endeavor is to obtain perfect freedom from pathogenic organisms; in the other case it is to destroy any pathogenic organisms which may be present in the wound, upon the hands of the surgeon, or upon the dressings. If absolute asepsis could always be assured, antisepsis would be unnecessary. It is because there are so many sources by which bacteria may get into a wound, even when done under the supervision of the most careful surgeon, that many of us prefer to use antiseptic precautions in addition to cleansing the skin of the patient, scrubbing the surgeon's hands, and sterilizing the instruments and sponges.

In some cases the use of chemical agents may be deleterious because they act upon the patient's tissues in such a way as to produce irritation; at least, such is the case when they are applied in sufficient strength to render their antiseptic properties valuable. For example, an ordinary solution of carbolic acid or corrosive sublimate can never be put into the peritoneal cavity without danger. It is also possible that frequent washing of recent wounds with such solutions irritates the tissues and leads to greater exudation of serum after the lips of the wound have been approximated than would be the case if the wound was not subjected to such irritation.

As has been said in an earlier chapter, heat is the most perfect destroyer of vegetable fungi; therefore, instruments, sponges and dressings, which have been sufficiently heated are free from germs. If the instruments and sponges are kept in the water in which they have been boiled they can be used with impunity, provided that dust is prevented from falling into the receptacle. Such sterilized, or aseptic, water is far less irritating than water containing chemical antiseptics.

The antiseptic solution most often used for washing the skin of the patient and for scrubbing the surgeon's hands is water containing corrosive sublimate in the proportion of 1 : 1000 or 1 : 2000. This solution, however, is too strong to be used for irrigating cavities, because if any portion of the fluid should remain, as it often will do, there is great danger of producing corrosive sublimate poisoning. This is evidenced by the occurrence of vomiting and bloody stools. Betanaphthol (1 : 2500) is preferable for washing out such cavities because it is a non-poisonous agent. Betanaphthol, however, is not as powerful a parasiticide as corrosive sublimate. Boiled water, or steam which has been condensed in clean receptacles, should be used for abdominal operations.

Sublimate solution should never be used to sterilize instruments, because it tarnishes the steel and dulls the edges of cutting instruments. For such purposes a betanaphthol solution or a solution of carbolic acid (1 : 40) should be employed. If the surgeon prefers he may boil his instruments and let them stand in the water until it has sufficiently cooled to allow him to put his hands in it or until he is ready for their use. The vessels should be protected from atmospheric dust by covers. I, myself, prefer betanaphthol solution, as a rule, for instruments, because it does not irritate the skin of the surgeon's hands as do corrosive sublimate and carbolic acid, and because it is safer than boiled water as it is antiseptic instead of merely aseptic. The sterilization of instruments by baking in copper boxes has already been described.

When an operation is to be performed the instruments required should previously be put in trays containing sterilized water or antiseptic solution, and these trays should be set upon a table without being seen by the family or patient. All sponges, sutures and dressings must be sterile. The patient's skin must be made aseptic by thorough cleansing, the surgeon's finger-nails cleaned and his hands and arms scrubbed with soap and made free from possible pathogenic germs, his clothing covered with a clean operating apron, and his sleeves rolled up to the elbow; just before operating his hands should be dipped in a sublimate solution (1 : 1000) for a couple of minutes and the patient's skin washed with a similar solution. Every assistant should know his duty and attend to it alone. And no loud talking or unseemly jesting should be permitted. The assistants whose hands are to touch sponges, instruments, and the wound must be as aseptic as the surgeon. No one else should be allowed to handle anything. Nothing, unless it is germ free, is permitted to come into contact with the incised tissues. An instrument which has dropped upon the floor or touched the bed-clothes must be rejected until again sterilized. The surgeon must touch nothing that is not sterile, unless he sterilizes his hands again with an antiseptic solution or washes them in sterilized water before approaching the wound. He dare not put his hands into his pocket or scratch his head or face without endangering the patient's life by the possible conveyance of a single bacterium into the wound. It is, therefore, well to surround the seat of operation with sterilized towels laid over the clothing or bed coverings. These may be baked towels or towels soaked in sublimate solution and dried. A table or firm bed is preferable to a reclining chair because more steady, and not so easily disarranged by struggles during etherization. The patient's body and limbs should be covered and not exposed to the chilling influence of the air.

A skilful surgeon usually has the whole plan of the operation clear in his mind before starting, and proceeds to its completion by successive steps with confidence and without hurry. Where uncertainty of diagnosis exists, the plan of procedure may require modification as the condition is revealed; but this is very different from the vacillating course of the man who undertakes an operation without knowing exactly what he expects to do and constantly appeals to the surgical spectators for suggestions.

The occurrence of hemorrhage should be precluded by the use of the Esmarch elastic bandage, or by acupressure or digital pressure to the main arterial trunk. Much of the depression formerly attributed to shock was really due to hemorrhage occurring after injury or during operation. The surgeon should not, however, stop in operations to ligate the numerous little branches that bleed; for many of them will cease spontaneously, and others can be controlled by hemostatic forceps, applied by the assistants, until the operation is completed. Then ligatures can be used. In operations about the face it is especially noticeable that small vessels spurt very vigorously for a moment or so, but soon stop without ligation.

In major operations, as for the removal of tumors for example, the most difficult points should be attacked first. Let the operator get under the mass, if it be a tumor, as soon as he has made his cutaneous incision. Then he knows what he has to meet, and having controlled the sources of hemorrhage and mastered the grave complications, he can dextrously and with facility complete the work of removal.

The principles or fundamental laws of operative surgery are:

1. Obtain the services of an etherizer who will not require you to superintend the anæsthetic.
2. Take precautions to prevent hemorrhage, if the locality renders this possible.
3. After proper thought and consultation have the plan of operation clearly outlined in your own mind.
4. Have the patient, the instruments, yourself and your assistants absolutely aseptic.
5. Proceed systematically with the steps of the operation decided upon, and do not be led into a mixed operation by bystanders, unless unexpected developments in diagnosis occur.
6. Attack the greatest difficulties and dangers of the operation first.
7. Do not stop to tie any except large vessels, but let assistants apply hemostatic forceps, or make pressure with their fingers until incisions are completed.
8. When the operation is finished, stop hemorrhage and apply dressings.
9. Finally, remember that suppuration in an operation wound is usually, probably always, due to careless asepsis on the part of the surgeon or his assistants, except in those instances where the operation is done on tissues already suppurating.

Control of Hemorrhage.

The prevention and management of hemorrhage during operations will be considered in the chapter on Diseases and Injuries of Bloodvessels.

Sutures.

When a wound has a tendency to gape, and there is a probability that union by first intention can be secured by correct apposition of the edges, sutures are employed. They should not be used in contused and lacerated wounds, if tension is induced by adjusting the parts, or if the wound is not perfectly aseptic, and there is danger of preventing thereby the free escape of serum and pus.

The suturing materials most commonly used at the present time are catgut and silk. Occasionally wire or wormgut sutures are employed. It goes without saying that these sutures must be rendered aseptic, in order that they may not induce suppuration or other pathological conditions in the tissues into which they are inserted. Wire and silk sutures are rendered aseptic by baking, or by soaking in a strong antiseptic solution. Catgut is prepared and then kept in an antiseptic solution until it is used. I, myself, prefer catgut kept in alcohol, because the oily menstrua in which it is sometimes preserved make it disagreeable to handle. Antiseptic catgut and silk sutures and wire for suturing can be obtained from the instrument-makers. Surgeons often prepare the catgut sutures and ligatures themselves, by purchasing violin strings and rendering them antiseptic by some such formula as the following: Soak the catgut violin strings in oil of juniper wood for forty-eight hours, in order to remove the fat; then wash in alcohol, and store in fresh alcohol until required for use. It is best to thread the needles, which should be aseptic, before they and the gut are put in the antiseptic trays used at the operation; because the catgut, when taken from the alcohol, is somewhat stiff and shrunken, but when put in water becomes swollen and cannot, therefore, be threaded

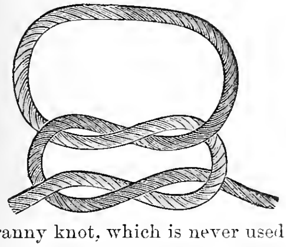
through needles with ordinary eyes. Such catgut sutures will become absorbed by the tissues in which they are placed in from five to ten days, varying according to the thickness of the thread. If it is desired to prevent the absorption of the sutures at such an early period—as happens, for example, when tendons or bones have been sutured—it is proper to use chromicized gut. This is catgut rendered less absorbable than ordinary antiseptic gut by the addition of chromic acid to the solution in which it is prepared. To chromicize catgut the following formula is a good one:

After having soaked the gut in oil of juniper wood for forty-eight hours, wash it in alcohol and let it soak for forty-eight hours in a solution prepared according to the following formula: Carbolic acid, 1 part; chromic acid, $\frac{1}{200}$ part; water, 20 parts; catgut, 1 part. After standing in this solution forty-eight hours the sutures should be washed in alcohol, and then preserved in fresh alcohol. Sutures, or ligatures, prepared in this way will be absorbed in from ten to thirty days, according to the thickness of the thread. The thicker the thread the longer the time required for absorption.

Since they are not absorbed in the tissues for many days, chromicized catgut sutures can often be used with advantage where wire sutures were formerly and are often still used. The advantage of catgut sutures, whether chromicized or not, is that the surgeon does not have to withdraw them after union has taken place, as is the case when wire sutures are used. Silk sutures are often cut and withdrawn by the surgeon, although they need not be when buried in the tissues, for they become encysted or absorbed. Sutures of silk upon the surface are, however, always withdrawn.

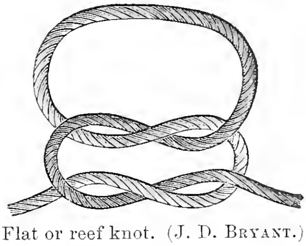
The forms of sutures usually employed are the interrupted, the continuous, and the twisted or pin suture. The quill suture is deservedly nearly obsolete. The interrupted suture is made by carrying with a needle a catgut, silk, wire, or wormgut thread across the wound, cutting it off and fastening the two ends by tying, twisting or clamping with perforated shot. This is repeated at intervals along the wound. The twisted, or pin suture, is made by thrusting a steel pin through the lips of the wound, which are then held in apposition by a silk or catgut thread wrapped around the ends of the pin and across the surface of the wound. The pin is left in position until union has occurred. The thread may be twisted about the pin in an elliptical or figure 8 manner, or a rubber band may be employed in its stead.

FIG. 43.



Granny knot, which is never used in surgery. (J. D. BRYANT.)

FIG. 44.

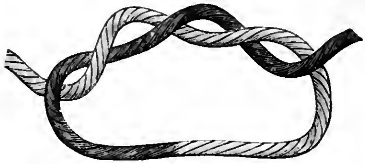


Flat or reef knot. (J. D. BRYANT.)

Interrupted sutures are best made with catgut, silk or flexible iron-wire and a straight needle. Occasionally a curved needle may be preferable.

In linear wounds the first suture should be inserted across the middle; in irregular wounds the projecting points had better be approximated first. The needle should puncture the skin not nearer than about one-eighth to half of an inch from the margin of the wound, and be carried deeply enough to bring the entire depth of the wound-surfaces together.

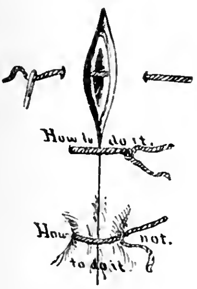
Fig. 45.



First tie of surgeon's or friction knot. The second tie is like that of the flat knot. (J. D. Bryant.)

The ends of the suture should be fastened at one side of the wound by a flat or reef knot if silk is used, by a surgical knot if gut is employed, by twisting the ends or clamping them with shot if wire is employed.

Fig. 46.



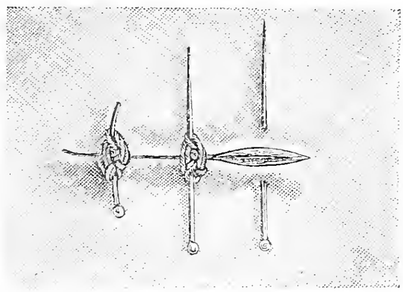
Interrupted suture of silk, showing the lower stitch too tightly tied. (Stephen Smith.)

Sutures should be placed at intervals of one-fourth or one-half inch, and should never be applied tightly, since mere apposition of the edges is all that is required and swelling will probably increase the tension. Sutures would be unnecessary if there was in wounds no gaping, or tendency to motion from muscular movements. A sufficient number of sutures should be inserted to avoid gaping between them. This is better than placing them far apart and using adhesive plaster in the intervals, since adhesive can scarcely ever be sterile. It is a useless and dangerous agent in the treatment of wounds. Three to six days is long enough, as a rule, for sutures to remain, though in deep wounds and in positions where strain is liable to occur, the sutures, if of wire, may remain almost indefinitely. When stitches are to be removed the wire should be cut close to the knot or twist, the long end bent over to the other puncture and the wire drawn through the tissues in a curved direction by means of a forceps grasping the knot. If this is not done, a little hook of wire is left when the suture is cut, and pain is caused by drawing this through the tissues. Catgut sutures need not be removed, because the portion of the loop buried in the tissues is absorbed and the external portion finally falls away from the skin. Chromicized catgut requires from ten to thirty days to be absorbed; ordinary antiseptic catgut is absorbed in from five to ten days. The time in each instance depends largely on the thickness of the thread of gut. Silk sutures may be cut and withdrawn, or, if entirely buried, may be allowed to remain in the tissues; when they are either absorbed as are buried gut sutures or they become encysted. These processes only occur perfectly when the sutures and wound are free from germs.

The twisted, pin, or hare-lip suture is especially serviceable when the wound is situated in movable tissues, as about the face, and additional support is desirable, and also where considerable hemorrhage is taking

place from the wound. The pins must be inserted rather deeply, carried transversely across the wound and brought out through the opposite edge of skin. The thread must not be applied too tightly. The sharp point of the pin is then cut off or guarded by a piece of cork. After three or four days, when union has occurred, the head of the pin is seized with forceps, the pin rotated and gently withdrawn. The thread is often left in place to afford support until it falls off under desiccating influences about the wound. A combination of the interrupted and twisted suture is sometimes judicious in wounds requiring support and accurate adjustment.

FIG. 47.



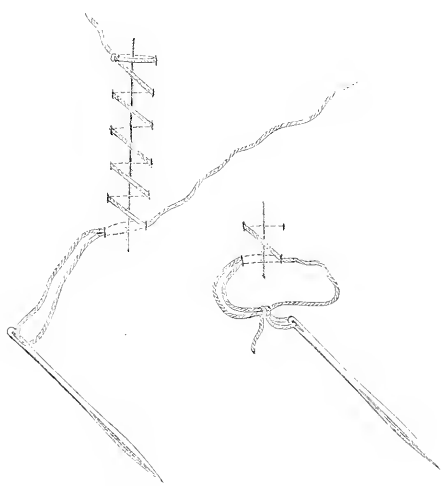
Twisted or pin suture. (WYETH.)

Continuous differ from interrupted sutures in that the first stitch is taken near the end of the wound and the thread carried through the tissues

FIG. 48.

Continuous suture. (ESMARCH.)

FIG. 49.



Showing beginning and final knot of continued suture.

from side to side without being cut off and tied every time it crosses the wound. This form of suturing is used a good deal more now than in the days when suppuration of wounds almost constantly occurred. At that time and under those circumstances the interrupted suture was convenient because one stitch could be removed for the evacuation of any pus which formed at the bottom of the wound cavity. Now that we have little fear of suppuration occurring the continuous suture is preferable in many instances, because it is much more rapidly applied than the interrupted and because it brings the edges of the wound

into neater apposition. When the continuous suture is begun the end of the thread of gut is tied to the main portion of the thread after the needle has drawn it through the second puncture. The needle then carries the thread across the wound and through the tissues in the way shown by the illustration. The suture is ended, at the other extremity of the wound, by tying the end of the thread and the loop made by leaving the thread long in the stitch next to the last. This method is shown in the diagram.

Buried sutures are stitches which are used to bring together tissues at the bottom of a wound, and which are subsequently entirely covered up by more superficial layers of muscle or fascia, or by skin. In closing large and deep wounds extending through different planes of muscle the surgeon should suture each layer of muscle and each layer of fascia step by step from the bottom to the surface. This hastens union, prevents the formation of pockets or cavities in which blood or wound secretions might collect, and restores most effectually the normal integrity of the parts. Divided nerve-trunks should be united by these buried sutures, severed tendons accurately approximated and muscular masses and fascial sheaths carefully reconstructed. Perfect asepticism is essential for success; catgut or silk sutures are to be employed for these purposes. In suturing tendons chromicized gut should be used, because ordinary gut is apt to be absorbed before the tendons unite, and because the strain upon the suture is often considerable. In all these instances the sutures are cut off close to the knots and are allowed to become absorbed or encysted. The peculiar method of passing the suture shown in the illustration is the best for tendons; other structures may be united by the interrupted or continuous suture as seems best to the operator.

Fig. 50.

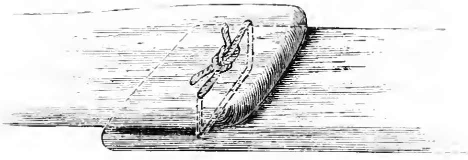


Diagram of suture of tendon. (Esmarch.)

The peculiar devices used for suturing intestinal wounds will be described under Surgery of the Abdomen.

Dressings.

The dressing which practically is used for all wounds, whether operative or accidental, is gauze. This gauze is what is technically called in trade circles cheese-cloth or butter-cloth. It is a loose cotton material with open meshes and readily absorbs fluids. It can be bought from dealers in surgical supplies, either plain or impregnated with corrosive sublimate or betanaphthol in varying proportions, and is, in the latter case, properly called antiseptic gauze. Plain gauze is supposed to be perfectly free from germs, which, of course, it never is, unless previously subjected to high heat and kept in cans tightly sealed. Cheese-cloth can also be readily bought at dry goods stores, and after it has been washed in hot water containing a little soda and dried, it becomes a very cheap and effective dressing. This the surgeon must make aseptic for himself, by baking it in an oven and keeping it free from the slightest

possible contamination with dust, or antiseptic by saturating it with a germicide solution.

When the wounds are open and the gauze dressing comes in actual contact with the wound surface the secretions on drying glue it to the wound. A great deal of pain is therefore given to the patient upon the removal of such a dressing, unless it has been carefully soaked for some time with water, which must be sterilized to prevent infection. It is well, therefore, to cover open wounds with a piece of thin rubber tissue or oiled silk "protective" before applying the gauze dressing. If rubber tissue is used it should be cut full of slits or small holes with a pair of scissors, in order that the secretions from the wound may escape into the gauze and not macerate the tissues lying under the rubber film. Evaporation and percolation are more free through the oiled silk, which goes by the name of "protective," than through rubber tissue, hence the former does not, as a rule, need to be perforated. If a wound has unfortunately become the seat of profuse suppuration the gauze will not adhere even when placed in direct contact with it. In wounds the edges of which are brought into actual contact by sutures there is no occasion for using "protective" under the gauze; the gauze may then be laid directly upon the wound itself. It must be understood, of course, that this rubber film or oiled silk must be thoroughly cleansed and rendered aseptic or antiseptic before being applied to the wound. It is perhaps unnecessary to say that all drainage-tubes, whether of rubber or of glass, must in a similar manner be rendered aseptic or antiseptic before use.

When a wound is dressed a large mass of gauze consisting of from four to twenty layers, varying with the degree of serous effusion which the surgeon presumes will escape from the wound, must be firmly and evenly bandaged over the injured surface. It is absolutely necessary that the margin of the dressing should extend a considerable distance beyond the limits of the wound, in order that the wound secretions may not, by travelling between the skin and dressing, get beyond the edge of the latter and become infected with bacteria from the air, clothing or bandages before the surgeon repeats his visit. In such an event the organisms will develop in the bandages or portion of clothing soiled with the discharge and cause putrefaction and suppuration; the infection will continue along the path of serum made under or in the gauze, and finally enter the wound. It is important, therefore, that no such entrance shall be made through or under the dressing by such a track of albuminous fluid extending to infected objects outside. The bloody serous transudate, which takes place from the wound, usually occurs within the first few hours. It is, therefore, wise to change the dressing of large wounds and of wounds where there has been a great deal of secretion, within the first twenty-four hours, because of the possibility of such fluids reaching the surface at some part of the dressing not easily examined by the surgeon. This second dressing will cause no annoyance or harm if it is done with the same attention to antiseptic precautions as is given to the first dressing. The hands of the surgeon and all instruments and dressings must be as carefully free from germs as at the time of the operation. After the second dressing no change is required until the fluid soaks through the gauze in the course of several days, or until pain in the wound or a marked rise in the temperature of the patient shows that some complication has arisen, and that the wound is not doing well. The drainage-tubes may often be removed at the time of the second dressing, unless suppuration has occurred, which condition, however, we do not

look for in aseptic wounds. If suppuration from any cause does exist in a wound tubes will be required, to give free vent to the pus.

In small wounds where there is but little effusion a single dressing is often sufficient, and by the second or third day the wound will frequently be found cicatrized. This sometimes occurs at the second dressing of quite large wounds when that dressing is not made for two or three weeks.

In my opinion the gauze should always be applied dry, because bacteria are much less liable to multiply in dry situations than in wet ones; hence a wet dressing seems to me to increase the possibility of microbic infection, even when these dressings have been moistened with antiseptic solutions. I prefer gauze which has been made aseptic by baking, applied dry, or gauze which has been impregnated with sublimate solution and subsequently dried. Gauze which has been sterilized by baking is not very absorbent. A small amount of glycerine sprinkled upon it before it is baked makes it absorb fluids much more efficiently.

When there is no wound and a poultice is desired to relieve pain it should be made of aseptic or antiseptic gauze, covered with oiled silk or rubber cloth to prevent evaporation. Poultices of flaxseed and similar material, are seldom used or desirable.

In some small incised wounds a dressing of collodion and iodoform, or collodion and boric acid may be used instead of a gauze dressing; for example, after the removal of a small tumor of the face a little collodion mixed with iodoform may be painted over the edges of the wound in such a way as to make an impervious varnish, which keeps the wound free from germs. Sometimes this collodion dressing can be made a little stronger by laying a small portion of aseptic absorbent cotton upon the wound and saturating it with collodion and iodoform or with collodion alone. Boric acid or corrosive sublimate would probably answer as well as iodoform to mix with the collodion and would be less obnoxious in odor. The mixture is painted upon the part after the catgut sutures have been used. If corrosive sublimate is selected, not more than an eighth or a quarter of a grain should be mixed with a fluidounce of collodion.

Bandages.

Roller bandages are used by the surgeon for the purpose of retaining dressings in position, making pressure, and restraining motion. A bandage is a strip of muslin, linen, or flannel, varying in width from one-half inch to two or three inches and in length from three to ten yards. It is applied smoothly to the surface by circular, spiral, and reverse turns, and should always make equable pressure and be firmly enough applied to its place during the ordinary movements allowed the patient.

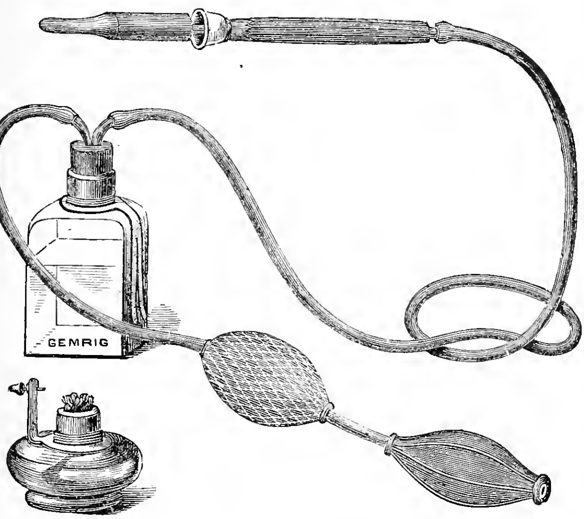
When a considerable amount of elastic pressure is required for promoting absorption, as in treating diseased joints and chronic ulcers, a bandage made of pure rubber is invaluable, though a flannel bandage will in some degree effect the purpose.

The Esmarch apparatus, which consists of a rubber bandage for expelling blood from a limb and a rubber tourniquet for preventing its return during the time of operation, will be discussed under Diseases and Injuries of Bloodvessels, where hemorrhage is considered.

Counter-irritation.

When a mild form of counter-irritation is wanted, mustard plasters, tincture of iodine, water of ammonia, and similar agents, or dry cups, are applied to the skin; if vesication or blistering is desirable, cantharidal collodion, cantharidal citrate, or an iron disk heated by immersion in hot water is employed. More powerful revulsive agents are setons, caustic potassa, and the red-hot iron. The best form of actual cautery is the thermo-cautery of Paquelin, which consists of a double metal tube with a hollow platinum end through which a current of benzole vapor is blown by compressing a rubber bulb. If the platinum portion is first moderately heated in a lamp, it can be raised to and maintained at a red or white heat by keeping a constant current of benzole vapor circulating within it.

Fig. 51.



Paquelin's thermo-cautery.

This is an exceedingly convenient and manageable instrument. Ordinary cautery or soldering irons, heated in a furnace, answer the same purpose. The electro-cautery is usually inconvenient for the surgeon's use. The pain felt from the cauterization after the patient recovers from anæsthesia can be averted by painting the burned surfaces with undiluted carbolic acid before sensibility is regained.

Counter-irritation is sometimes obtained by thrusting needles into the tissues—a method termed acupuncture. The needles may be arranged in a bundle and propelled by a spring, or may be introduced singly by the fingers of the surgeon. Additional irritation is induced, when necessary, by dipping the points in croton oil.

Abstraction of Blood.

Local abstraction of blood by leeches has been superseded, to a great extent, by multiple punctures and scarifications with a sharp knife and by wet cupping. In both cases the flow of blood is encouraged by affu-

sions of hot water. General bloodletting is accomplished by opening a vein, usually at the bend of the elbow, or, when a sudden and powerful impression is required, by incising the temporal or radial artery.

When venesection from the arm is to be performed, a bandage is tied around the arm above the elbow, sufficiently tight to prevent the venous return but not firm enough to prevent the downward arterial flow. The veins then become distended. The arm must next be made aseptic, after which the operator, selecting the median cephalic vein because it is not in close relation with the brachial artery, steadies it with the thumb and forefinger of his left hand, and makes an oblique incision into it by transfixing it with the point of a bistoury. The incision must be a free one to allow the blood to escape in a jet. If the median cephalic vein is not large enough to give a good flow, the median basilic or any one that is prominent may be selected. It must be remembered that the brachial artery lies under the median basilic vein; but if the vein is transfixed laterally with the point of a knife and the incision made from within outward, there is no danger of wounding the artery. The old-fashioned spring lancet is much more dangerous, and is inferior to an ordinary bistoury for such an operation. The vein can be nicely steadied for the incision by passing a small acupressure or harelip pin through the skin and underneath the vessel. This is better than attempting to prevent its slipping away from the bistoury by means of the fingers.

Phlebotomy should be done when the patient is in the semi-recumbent position. Removal of the bandage around the arm will stop the flow of blood, after which an antiseptic pad is placed over the wound and the limb kept comparatively quiet for a day or two.

Arteriotomy is performed by merely cutting down upon the pulsating vessel and making an oblique or transverse incision into its wall. When the amount of bleeding is satisfactory, the vessel should be completely divided and pressure applied; or ligatures may be put upon the ends of the artery.

Aspiration and Tapping.

Aspiration is the evacuation of fluids by means of a vacuum connected with a hollow needle or a canula, and is advantageous because it prevents the admission of air to the cavity from which the fluid is taken. Hence septic changes are avoided. The aspirator, as perfected by Potain, consists essentially of a reservoir which is connected with an exhausting pump and from which a tube passes to be connected with a hollow needle or a canula and trocar. Stop-cocks are provided to prevent the admission of air to the tubes and reservoir or to the cavity to be tapped.

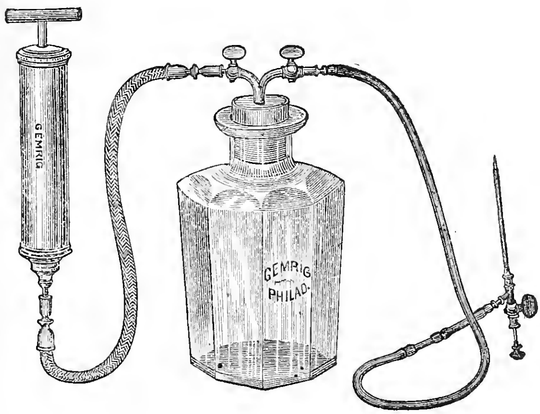
When an abscess or serous collection is to be aspirated, a vacuum is created in the reservoir with the air-pump, and the needle introduced into the tissues. The vacuum chamber is then connected with the needle by turning a stop-cock, and as soon as the point of the needle enters the cavity atmospheric pressure forces the fluid into the chamber.

When an aspirator is not at hand, or when it is desirable to have less pressure than that induced by a vacuum, the principle of the siphon may be utilized by attaching a long tube to a trocar or hollow needle and carrying the end below the level of the patient.

The hypodermatic syringe answers admirably for aspirating small cysts and abscesses, and is also of great value in determining the character of obscure swellings. The grooved exploring needle, so frequently used, is

far inferior to the hollow needle and syringe, and is never used by me for diagnostic purposes. Motion of the end of the hypodermic needle will often disclose a cavity, even if the contents are too viscid to escape through the orifice into the glass barrel of the hypodermic syringe.

Fig. 52.



Aspirator.

When the entrance of air into the cavity to be evacuated is considered unimportant a trocar and canula are employed. In using a trocar the surgeon should make the parts tense by pressure with the fingers of the left hand, select a point free from veins or arteries and plunge the trocar and its surrounding canula through the skin with a sudden rotary thrust. As long as fluid flows freely enough to fill the entire calibre of the canula no air will enter. Such a free flow can be kept up until the sac is nearly empty if pressure is made upon its walls by the surgeon's fingers.

In many instances open aseptic incision is preferable to either aspiration or tapping, which are too often the resources of a timid and dilatory surgery. They have, however, a legitimate field.

CHAPTER XII.

PLASTIC OR REPARATIVE SURGERY.

Under the term plastic surgery are grouped those operations which have for their object the construction of absent parts, usually from the patient's own tissues, and the reposition or curtailment of parts displaced or deformed by accident or disease.

The word plasty is often used with a prefix to indicate the organ formed; thus, rhinoplasty means the reconstruction of a nose, cheiloplasty the formation of a lip.

Plastic surgery is called into play to overcome both congenital and acquired defects and deformities. Its objects, therefore, may be stated to be: To correct deformity due to imperfect fœtal development, as harelip and cleft palate; to replace parts lost or deformed by injury or ulceration, as in closing fistules or clefts, and reconstructing destroyed noses or lips; to relieve or prevent distortion from cicatricial contraction, as after burns and cervical abscesses and the removal of tumors requiring ablation of a large amount of integument; and to curtail organs rendered unseemly by abnormal growth, as in greatly hypertrophied nose or tongue, and in large and protruding ears.

The structures used in constructive operations are especially skin and subcutaneous cellular tissue, though mucous membrane, which becomes somewhat like skin when removed to the external surface, muscle, periosteum, and even bone, are at times successfully utilized.

The steps of a plastic operation are to be followed in regular succession and the plan of procedure should be clearly fixed in the operator's mind before he makes the first incision.

The patient must be in good health, so as to be less likely to have erysipelas or ulcerative action attack the wounds made. When parts destroyed by syphilis are about to be reconstructed, it must be ascertained that no syphilitic manifestations have occurred for several months, since a recurrence of specific ulceration would destroy the success of the plastic operation and perhaps render future measures impossible. The operation should be rigidly aseptic.

The successive steps are: Freshening the edges of the vacuity to be filled and obtaining one or more flaps if such are required; arresting all bleeding, since clots between the raw surfaces may prevent union by first intention; adjusting the parts in proper relation without tension and retaining them in apposition by sutures; closing the gap left by removal of the flaps, if such have been employed; dressing all the wounds antiseptically or aseptically, and preventing motion and frequent handling of the parts.

In complicated reparative procedures it is often necessary to accomplish the desired end by a series of operations, each one of which effects a result which affords a basis for subsequent measures. The time between any two operations may be weeks or months, for the secondary operation should not be undertaken until cicatrization and shrinkage have fully determined the condition gained by the primary one.

Sutures of catgut, plain or chromicized, of silk, and of wire are used according to the length of time their sustaining power is needed. In applying the sutures, doubling in of the edges of the flaps can be prevented by introducing the needle obliquely, so that the punctures on the inner surface are further from the margin than the external punctures. This causes the apposed sides to pout out a little at first, but the protrusion disappears with cicatrization; if not, it can be pared away subsequently. A few deeply placed sustaining sutures may be advantageous in maintaining approximation when the plastic operation requires the union of large surfaces extending inward to a considerable depth, or buried sutures may be employed. The strain is thus taken from the superficial sutures, and rapid union of all portions of the wound is encouraged. Sometimes the support given by the pin suture makes it preferable to the interrupted or continuous sutures. Silk or gut sutures are sometimes employed between metallic ones to make very accurate apposition of thin edges. Their early removal or absorption, before it is safe to take out the deeper metallic sutures is not disadvantageous.

The tongue-and-groove sutures of Dr. Joseph Pancoast is often a very excellent method of maintaining apposition in rhinoplasty and operations for exstrophy of the bladder. It consists in slipping the flap margin, which has been bevelled, into a groove made by dissecting up the edge of skin surrounding the raw surface to be covered.

Fig. 53.

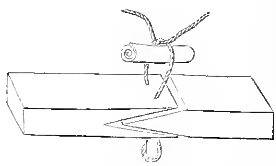


Diagram of tongue and groove suture.

Four raw surfaces are thus apposed. Wire or silk sutures are then applied, as shown in the diagram, and fastened over a perforated disk or a pad. It is easy to adjust the sutures by having both ends armed with needles.

The gap left by the removal of the flap in plastic operations should be closed, if possible, by drawing the integument together, or by inserting a flap taken from the neighboring skin if it can be obtained from a site which will put the cicatricial tension in a less objectionable locality. If neither means is applicable provision should be made for healing by granulation. Often the tissue dissected away to make a raw surface for adhesion of the flap can be utilized for closing the hiatus left by the elevation of that flap.

The various plastic procedures are included in the three methods of operating which I shall term respectively the methods by displacement, by interpolation, and by retrenchment. Under the displacement method are included operations done by simple approximation and by sliding; under the method of interpolation are classed procedures accomplished by transference and by transplantation.

The relations and characteristics of these modes of operating will be seen by the schedule.

Methods used in Plastic Surgery.

DISPLACEMENT—stretching or sliding of tissues.

I. *Simple approximation after freshening the edges*, as in harelip, vesico-vaginal fistule, and notches caused by tearing out ear-rings.

II. *Sliding into position after transferring tension to adjoining localities*, as in V-shaped incision for ectropium and cicatricial contraction of joints after burns, and in linear incisions to allow stretching of skin to cover large wounds and to relax contracted parts.

INTERPOLATION—borrowing material from adjacent regions, from a limb, or from another person.

- I. *Transferring flap with a pedicle.*[1]
  - *A.* Putting in place at once.
    1. By rotating flap on the pedicle in its own plane through one-fourth or one-half a circle, as in making upper eyelid or nose from forehead.
    2. By twisting flap on its pedicle, as in making side of nose from lip.
    3. By everting flap entirely so that raw surface is uppermost, as in covering exstrophy of bladder by a scrotal flap.
    4. Superimposing one flap on another which has been everted. This is done where a thick wall is desirable, as in closing the front of an exstrophy of the bladder.
    5. By jumping, or carrying flap across a bridge of skin, and fixing only its end to the part to be repaired. When the flap has become attached the pedicle is severed. This manœuvre is rarely employed.
  - *B.* Putting in place gradually by successive migrations, by same manœuvres as when the flap is placed at once in its permanent position.

    This method is not very commonly needed, but may be valuable when there is nothing but cicatricial material in the immediate vicinity of the part to be repaired.
- II. *Transplanting without a pedicle.*
  - *a.* By carefully suturing or fixing in the gap areas of tissue recently dissected from distant regions, or taken from the lower animals; such as replacing the bone button after trephining, inserting portions of nerve-trunks in wounded nerves, etc.
  - *b.* By skin-grafting with small pieces or large shavings of skin. This is the manœuvre of this class that has been followed by the greatest success. As it lessens cicatricial contraction it may be advantageously used at times in plastic operations that necessarily leave surfaces to heal by granulation. Skin from the frog's abdomen may answer well.
  - *c.* By readjusting finger-tips, ears, and noses recently completely severed by injuries.

RETRENCHMENT—removing superfluous material and causing cicatricial contraction.

- I. By cutting out elliptical or semi-elliptical pieces of tissue, as in ptosis, cystocele, and prolapse of the rectum.
- II. By cutting out triangular or wedge-shaped portions of tissue, as in closing the vaginal aperture, decreasing the size of a lip, ear, or nose, and separating webbed fingers.

Retrenchment is often valuable because it decreases the relative size of features; thus, if a nose has been partially lost the upper lip appears too large, and its diminution will render the deficient nose less noticeable. When material is taken from the prominent feature, and especially if added to the other the normal proportion is nearly reëstablished and deformity greatly concealed.

To secure success in plastic devices certain precautions should be observed. In the first place, the patient should be in good general health and free from irritation or inflammation about the seat of the proposed operation. In transferring or transplanting it is essential to select normal integument for the flap, because cicatricial tissue is almost sure to slough if dissected from the subjacent structures. Approximation and sliding operations, however, may be successfully performed with cicatricial tissue, because these methods interfere very little with the vascular supply from beneath.

All flaps should be made large, thick, and with a good vascular supply through a wide pedicle. As soon as the flap is dissected loose, it shrinks and becomes paler and cooler. Hence, it should consist of skin and plenty of subcutaneous tissue, because thick flaps contract less and are more vascular. It should be made about one-third larger in area than

[1] When a flap is borrowed from the arm or hand there is less necessity for rotating and twisting than when it is taken from the neighborhood of the organ to be constructed. The latter is generally the preferred method, however, because less irksome to the patient than the former with its constrained posture.

the space to be filled and should be allowed to cool as little as possible by being placed in position as quickly as practicable. For the last two reasons I consider it preferable to freshen the edges of the part to be repaired before making the flap. This is especially true in transplanting flaps.

It is sometimes well to cut a diagram of the flap out of paper or cloth, and mark a similar outline upon the skin with ink before beginning the dissection of the flap. It must be remembered that when the flap is formed it contracts very much. At the same time the gap from which it was taken appears larger than is really the fact because of retraction of the margins of the wound. Nevertheless, it is well to make the flap at least one-third larger and much thicker than the space into which it is to be interpolated would seem to require, since the flap shrinks at once and undergoes contraction and absorption from cicatricial changes for many weeks after union has occurred. Any reduudancy can be readily removed when lapse of time proves it actually to exist.

To guard against imperfect nutrition and consequent sloughing of the flap, it is well to make it with its long axis corresponding with the direction of arterial supply, and its base presenting toward the cardiac portion of the arteries. Where there is very free anastomosis, as upon the face, this rule may be disregarded to a considerable extent. The calibre of the supplying vessels must not be interfered with by too much twisting or tension of the pedicle, which must always be wide and thick. Injurious tension on the pedicle can frequently be prevented by cutting a pedicle with curved margins, which will allow increased stretching without occluding the vessels. Skin free from hairs should be selected when possible, unless it is desired to make eyebrows.

A gap to be filled by interpolation and parts to be united by approximation should have their surfaces prepared by such free incisions as will give abundant areas of contact for union by first intention. It is an error to pare away so little tissue that only a thin raw edge is obtained. It is necessary to have broad surfaces of contact to make successful plastic operations, and these must be obtained even at the sacrifice of considerable material. The additional material removed will not be so great but that it can be supplied during the subsequent steps of the operation.

Operations for harelip and torn perineum are often imperfect because of neglect of this rule.

When all hemorrhage from the flaps and freshened edges has been controlled, accurate approximation is to be made by numerous sutures, which should hold the parts merely in contact, allowing them to lie loosely and without tension. It is important in constructing new noses and other features to be satisfied at first with obtaining a bulky semblance of the organ, and not to endeavor to trim down the structures to an accurate conformation, because it is impossible to estimate the amount and character of cicatricial shrinkage which will inevitably occur.

Exudation and organization of lymph sufficient to hold the parts together with moderate firmness occurs in from two to three days; then some or all of the sutures may usually be removed. Metallic sutures cause so little local irritation that they may be allowed to remain as long as there is any danger of disruption of the adhering parts. The silk sutures, which are often useful in securing accurate adjustment at the very edges of the wounds, are generally removed early. Gut sutures may be allowed to remain until they fall off from absorption of the portion lying in the tissues. Absolute antisepsis adds greatly to the success

of plastic operations, and causes healing with the minimum degree of scarring.

In transplanting without a pedicle, it is of the utmost importance that the tissues be kept absolutely aseptic and warm. Disks of bone, pieces of nerve, skin shavings, and such tissues, when to be thus used, should be kept warm in sterilized water of about 105° F. If antiseptic solutions are employed, they should be weak and unirritating.

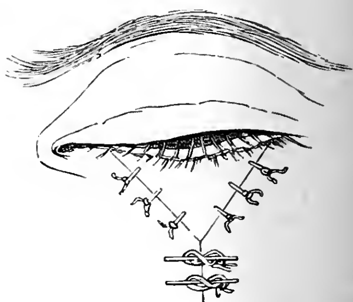
The success following well devised and carefully performed plastic operations is very gratifying. It is especially so in cosmetic operations, since the improved appearance, though not equal to the normal condition, is of great solace to the disfigured patient. It is always a long time before the cicatrices become white and soft; therefore the full result is not apparent until many months have elapsed. The scars always remain visible, however; hence the illustrations of many published cases are deceptive in the apparent absence of scarring.

The disabilities due to fistules, ruptured perineum, and many other conditions, can often be entirely removed by plastic surgery. If gangrene of the flap does not occur before the end of the fourth day it is not likely to take place, and the integrity of the operation is pretty well assured. If, however, during the first three or four days the flap becomes grayish and pulpy, and shows a loosened cuticle, or, on the other hand, if it assumes a dry and withered appearance, it is evident that destruction by sloughing of more or less tissue is supervening. The surgeon should, nevertheless, leave the parts in position, keep them warm, and disturb the dressings as little as possible, because the gangrene may involve only the edges or the superficial layers of the flaps. A small amount of living tissue remaining after the limitation of the sloughing process will often be very serviceable in making the operation entirely, or at least partially, successful.

FIG. 54.

Plastic operation by V-shaped flap to correct eversion of lower eyelid.

FIG. 55.



Plastic operation by V-shaped flap. Sutures applied. (STELLWAG.)

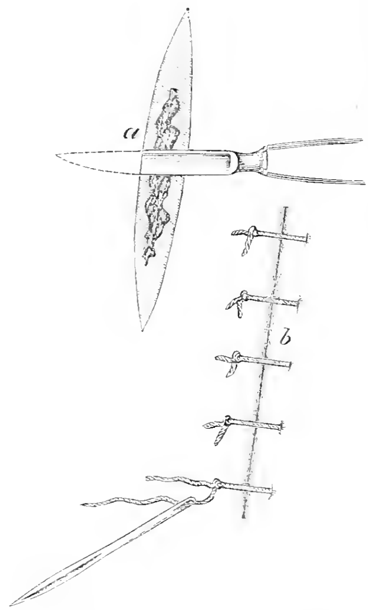
To illustrate the manner of doing plastic operations, I shall describe a few of the plans that will be found useful. As every case has peculiarities of its own, the illustrations are given merely as types which will prove suggestive.

Harelip, as will be shown in another part of this treatise, is usually remedied by paring the edges of the cleft and approximating the freshened surfaces with the pin suture. Ectropium, or eversion of the lower eyelid from cicatricial contraction, is greatly improved by making a V-shaped incision downward, with its base embracing the everted section of the lid, and dissecting the tense structures from the adjacent muscles so that the V-shaped area of the skin can be slid upward until the lid assumes its natural position. This relieves the downward tension without materially disturbing the blood-supply of the somewhat poorly nourished cicatricial tissue. The gaping wound left below and laterally can usually be closed by stretching the skin or by interpolating flaps.

This principle of relieving tension can be utilized in many regions after deformity from burns. The point of the V must always be in the line of greatest tension.

Depressed and irregular cicatrices, such as occur in the neck after chronic suppuration of lymphatic glands, can be rendered more sightly by carrying an elliptical incision around them, freeing the integument laterally, and drawing the under-cut skin over the depression, which has previously been made raw by abrasion.

Fig. 56.



Operation for depressed scar. *a* shows lines of incision around depressed scar, and knife separating skin from underlying tissues. *b*. Edges sutured after being drawn to middle line over depressed tissues which have been made raw by scraping.

This method gets rid of the depression and leaves a linear cicatrix. It has been proposed by Mr. Adams to cut loose the deep attachments of such scars with a tenotome, and then to keep the scar tissue raised for a few days by pins inserted beneath. Elevated scars can be excised as tumors, though the redundancy sometimes returns.

Plastic operations for reconstructing the nose may be made by transferring flaps from the forehead, or from the arm as suggested by Taliacotius. The septum, or at least the columna, can be well made out of a piece cut from the entire thickness of the upper lip. Portions of the nose may be restored by flaps from the cheeks or upper lip. It is well to remember that taking portions of the lip away gives a flattened nose a more marked prominence; hence, two indications are fulfilled by using labial flaps for rhinoplastic procedures. The parts may be kept in place by transfixing the organ and the septum with pins, or tubes or plugs may be placed in the nostrils for a few days. When the bridge is very much shrunken, flaps from the forehead and cheeks may be superposed to give thickness. The lower lip can be repaired by flaps from the chin or cheeks, from the upper lip if the loss of substance is near the angle of the mouth. The plastic operations by which crooked noses and other

deformed features are improved vary with the character of the distortion.[1]

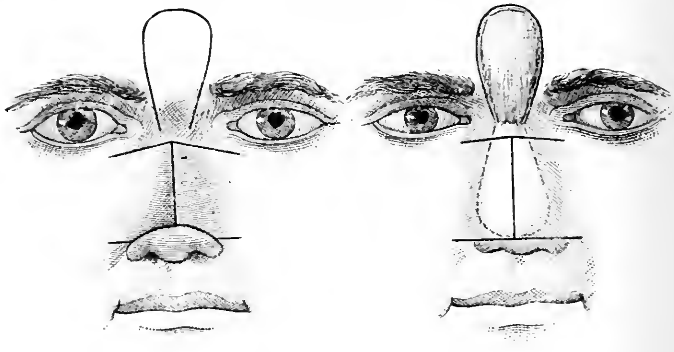
Fig. 57.

Outline of flap taken from forehead for reconstruction of nose. (Bryant).

Fig. 58.

Outline of flap taken from upper lip for reconstruction of ala of nose.

Fig. 59.



a

Shows outline of flaps for making the nasal bridge higher. (Stimson.)

b

Shows the frontal flap turned down under the lateral flaps. The raw surface on forehead is left to granulate. (Stimson.)

Fig. 60.

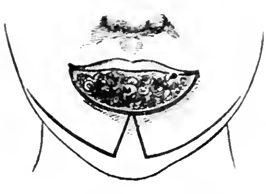


Fig. 61.

Plastic operation for reconstructing lower lip. (Erichsen.)

[1] See author's monograph on the Cure of Crooked and Otherwise Deformed Noses.

PART II.

SPECIAL SURGICAL PATHOLOGY, OR PRACTICE OF SURGERY.

CHAPTER XIII.

SURGERY OF SPECIAL STRUCTURES.

DISEASES AND INJURIES OF THE SKIN AND ITS APPENDAGES AND OF THE SUBCUTANEOUS TISSUE.

The cutaneous eruptions do not belong to the domain of surgery, and therefore will not be discussed in this treatise. Ulcers, wounds of the soft parts, and tumors have had sufficient attention given them in the preceding chapters, hence no further reference to them is required in this connection.

Wart or Verruca.

Definition.—A wart is a circumscribed hypertrophy of the cutaneous papillæ.

Pathology.—It is in fact a papilloma, and may have a smooth or rough surface according to the arrangement of epithelium covering the enlarged papillæ. The histology of papilloma is discussed in the chapter on tumors. Warts may be quite hard and horny, as in the common form found on the hands, moderately soft, as seen upon the backs of old persons, or very soft and friable, as the moist verrucous vegetations situated upon the anal and genital muco-cutaneous surfaces. The last are not syphilitic, but depend upon an irritation due to muco-purulent discharges of any kind. The discharge may be venereal, but this has nothing to do with its causing the warts. The growths are very vascular and may be the source of hemorrhages. The fetid odor is due to decomposition of the secretions. The other forms are not very vascular and are usually darker than the adjacent skin. Warts on mucous membranes often bleed freely and in the bladder and urethra may cause obstruction to urination. A warty growth occurs on the hands of those engaged in making post-mortem examinations, as a result of irritation from the cadaveric fluids.

The horny wart at times disappears spontaneously, hence the reputation of many household applications.

Treatment.—Excision with scissors or curette or repeated cauterization with chromic acid, glacial acetic acid, or ethylate of sodium is the best treatment. A mixture of salicylic acid (gr. xxx), extract of canna-

bis indica (gr. x), and collodion (℥j) is recommended to be applied daily. After a few days the devitalized tissue should be scraped off. Ligation may be employed if the wart is pedunculated.

The soft warts, often improperly called venereal vegetations, may be treated in the same way, though, when large, provision against hemorrhage must be made by the surgeon being ready to apply pressure or astringents. Powdered tannic acid I have found a good styptic application. The écraseur or the actual cautery may be used for removing very large masses of these vegetations.

Corn or Clavus.

Definition.—A corn is a small, circumscribed, cone-shaped callosity, due to hypertrophy of the epidermis, usually situated upon the feet or hands, and having its apex pressing upon the papillary layer of the skin.

Pathology.—A corn is originally a papilloma or wart, but as the epidermis thickens it is pressed into the underlying tissues like a nail driven into a board and the papillæ finally atrophy.

The cause of corns is pressure, of misfitting shoes or from some instrument used in manual labor, which induces chronic inflammatory hyperplasia.

The pain is due to pressure on the delicate papillary layer of the true skin, between which and the callosity a small bursa is sometimes developed. If active inflammation and suppuration occur beneath the corn, the pain is intense, because the pus cannot escape through the thickened epidermis.

When moisture is constantly present, as between the toes, the corn is macerated and is called a soft corn. Pathologically hard and soft corns are the same. A hard corn is occasionally found under the toenail.

Treatment.—The treatment consists in removing pressure by wearing broad-soled shoes, straight along the inner border, with low heels. The hardened epidermis may be scraped or cut away. This is best done perhaps after softening the epidermis by soaking in hot water, by poultices, or by applications of alkaline solutions, such as sodium carbonate (gr. x to f℥j). In using strong alkalies care should be exercised not to touch surrounding parts. The corn may be surrounded with a ring of wax. As the removal of the horny exterior relieves the pressure on the true skin, pain will be mitigated by these measures. A thick pad or plaster with a central perforation to admit the callosity will palliate pain in the same way. The salicylic acid application given for the treatment of warts is often beneficial in cases of corns. Strong applications of nitrate of silver will often relieve the pain of either hard or soft corns. Inflamed corns require elevation of the foot and moist antiseptic dressings. Gauze moistened with an antiseptic solution and covered with rubber tissue, oiled silk or waxed paper is an antiseptic poultice and is valuable. Soft corns are benefited by dusting tannic acid or oxide of zinc upon them. These modes of treatment are only palliative. Excisions of the horny cone-shaped mass by careful dissection or by cutting out an elliptical portion of tissue down to the superficial fascia is the radical treatment. If abscess occurs under the corn prompt incision will relieve pain and probably effect a permanent cure.

It must be remembered that the peripheral circulation in the feet of old and infirm persons is not vigorous; hence, slight operative interference may be followed by gangrene in such patients.

Boil or Furuncle.

Definition.—A boil is a circumscribed, painful, and reddish elevation, due to a localized inflammation of the skin and cellular tissue usually terminating in central suppuration and sloughing.

Pathology.—Furuncles occur singly or scattered over the surface in crops, showing a predilection for the back, axillæ, perineum, buttocks, legs, and face.

They are at times associated with diabetes and other diathetic conditions.

There seem to be two classes of boils: Those primarily superficial, due to local irritation about a hair follicle or sebaceous gland, as when the hands are exposed to irritating fluids in dissecting; and those which begin deeply on account of a localized depressed state of resistance in the cellular elements of the skin and subcutaneous tissue. Boils occur among those of depraved physical condition and in those of robust and vigorous health. Sea air has a tendency to induce their appearance in many people. The cause of furuncle is a mycotic one. The cocci in many instances enter the sebaceous duct or hair follicle from the surface of the skin. In other cases, probably, they are in the blood and become localized at a point where the tissues have least resisting power. This explains the location of boils and their occurrence in the healthy.

Symptoms.—The sharp stinging pain felt upon accidental pressure may first call attention to a small, red pimple, which gradually enlarges, becomes hard and purplish, and is surrounded by a red areola. The pain becomes throbbing and constant, about the fifth day a yellowish spot at the apex of the elevation proclaims the occurrence of suppuration and in a day or two longer a cylindrical greenish-yellow core or slough of cellular tissue is discharged by the suppurative process, leaving a deep, punched-out looking cavity. This is gradually filled by granulations, the adjacent exudation of lymph is absorbed so that the tissues around regain their normal softness, and cicatrization is finally accomplished.

The course of a moderate size boil, that is, one which with its areola is say 1½ inches in diameter, is run in eight or ten days. Pain subsides as soon as the slough or core is discharged. Smaller boils or pimples frequently appear about the same locality some days after the disappearance of the primary boil. Lymphatic glandular involvement is common during the height of the inflammation. Occasionally the inflammation terminates by resolution, and as no discharge takes place such furuncles are termed blind boils. Severe boils usually cause some fever.

The diagnosis between furuncle and its congener, carbuncle, is made by the single point of suppuration, the circular and conical shape, the smaller size, the tenderness on pressure, which does not exist in carbuncle, and the usual association with other boils.

Treatment.—It is sometimes possible to abort furuncle by early applications of tincture of iodine, nitrate of silver, blisters, or undiluted carbolic acid, or by puncture with a red-hot needle; but such procedures seem at times to cause the subsequent irruption of a more than usually virulent furuncle, which cannot be kept in check by such measures. Carbolic acid has been injected into the forming boil with alleged advantage.

Pain is quieted and suppuration probably hastened by wet antiseptic dressings covered with rubber tissue or oiled silk so as to constitute poultices, and by anodyne plasters, of which belladonna plaster is one of the

best; but these are far inferior to early and free incision, which relieves tension and pain, depletes the engorged tissues and allows rapid extrusion of the slough. It is the effort of the dead cellular tissue to escape that, in the majority of instances, causes much of the pain. My usual course is to wait only until the boil becomes quite painful, when I at once make a deep incision without waiting for pus.

Scraping the diseased tissue out with the curette while the patient is etherized may hasten cure. This, especially if followed by moist antiseptic dressings and removal of the slough with forceps, speedily relieves pain and shortens the duration of the disease several days. Dry antiseptic dressings should be used after the slough has been removed or discharged.

The treatment of the condition giving rise to a succession of boils (furunculosis) is difficult, because a determination of the underlying causes is often impossible. Impoverished blood demands iron, quinine, mineral acids, cod-liver oil, malt and alcoholic beverages, and pure air. Arsenic (gr. $\frac{1}{20}$ to $\frac{1}{15}$), hyposulphite of sodium (ʒss to ʒj), sulphide of calcium (gr. ij to gr. iv), and solution of potassa (♏xv to ♏xxx) have some reputation as antagonists to the furunculous diathesis, and one or other may be administered three or four times daily. Eliminative measures, such as the Turkish bath, should be employed; and any gastric, intestinal, or genital derangement corrected. Thorough cleansing of the skin with soap, aided, perhaps, by turpentine, ether, and non-poisonous antiseptics, seems most philosophical. The occasional association of furunculous inflammations with syphilis, septicæmia, nephritis, and diabetes must not be forgotten. When healing does not progress after separation of the slough, the superficial ulcer left requires such management as has been previously detailed in the discussion of ulcers.

Carbuncle.

Definition.—Carbuncle is a more or less localized, deeply seated suppurative inflammation of the skin and cellular tissue, attended by a hard, very painful, flattened swelling and asthenic symptoms.

Pathology.—This section does not discuss the disease called malignant pustule, or anthrax, which is spoken of in an earlier chapter. Unfortunately the term anthrax is applied to both diseases. They may be related. Malignant pustule is certainly due to the anthrax bacillus. Carbuncle is probably due to a pyogenic organism. There is a great clinical similarity between furuncle and the more severe disease, carbuncle; while there is apparently a pathological or etiological relationship between carbuncle and malignant pustule and erysipelas.

Symptoms.—Carbuncle is usually single and is most frequent in elderly people and in those of impaired health; it is often associated with diabetes and chronic renal disease. A chill may be the premonition of the carbuncle, which appears as a painful red spot, perhaps surmounted by a vesicle. The posterior part of the trunk and neck is its favorite locality. A firm, flattened, dusky red swelling. evidently involving a considerable depth of tissue and exceedingly painful, though the pain is not much increased by pressure, soon shows that a mere furuncle is not to be expected. The brawny inflammation is localized, though it evinces some tendency to spread, which is quite unlike the sharply defined furunculous affection. This suggests a possibility that carbuncle may be due

to the streptococcus pyogenes and furuncle to one of the other pus-causing fungi. The feeling of tension and the throbbing pain are very marked, the muscles in the vicinity become stiff from pain, and glandular swelling is quite prominent. After the lapse of ten days or two weeks the skin softens, first perhaps becoming vesicular, and is riddled by gangrenous openings through which sloughing cellular tissue and ichorous pus is discharged. Tough fibrous cores or sloughs are extruded and the continuous destruction of skin goes on until there is left a deep excavated ulcer with irregular indurated margins. The diameter of a carbuncle varies from one to six inches and it may extend down to the underlying muscular tissue, but rarely goes beyond. The duration of the disease is a month or six weeks, though this period may be greatly lengthened by indolent cicatrization of the ulceration. The prognosis is exceedingly unfavorable when the carbuncle is large and situated upon the head or neck, especially if the patient is old or infirm.

The constitutional symptoms are asthenic, and are of course more grave if the sloughing causes profuse hemorrhage.

Treatment.—The internal treatment, therefore, comprises supportive and anodyne measures, for even preliminary depletion would be inadvisable. Quinia (gr. x–xx daily), dried sulphate of iron (gr. iij–vj daily), and milk punch (whiskey, f℥ j–v daily) represent the character of agents to be employed in severe cases.

Ice has been recommended as a local application in the early stage to cause the disease to abort. Blisters are sometimes employed with a similar object, and are also sometimes applied around the carbuncle to prevent extension of the inflammation by causing abundant effusion of serum. Circular compression made by plasters with a central hole over the focus of inflammation or by a cupping glass has advocates, who think that the progress of the carbuncle is limited or its severity lessened by this device. When it is evident that arrest cannot be accomplished, moist antiseptic dressings, covered with rubber cloth to prevent evaporation, are the proper applications to hasten suppuration and the discharge of the gangrenous tissue. Thorough cleansing with sublimate solutions (1 : 1000) of the cavities under the perforated and sieve-like integument is judicious. Cicatrization of the resulting ulcer is accomplished as in ordinary cases of ulceration after gangrene. Stimulating ointments or lotions and skin-grafting may be required. The cicatricial contraction is usually less than would seem probable from the extent of the ulceration. This is due to the fact that the thickened and indurated edges give the ulcer a factitious depth.

I have purposely omitted the discussion of the propriety of incising carbuncles until now, because high authorities differ as to the therapeutic value of incision. Some surgeons seldom incise them and believe that the operation as a rule neither hastens cure nor lessens suffering. Others think that incision is beneficial because it relieves the tension and consequent interstitial strangulation, diminishes pain, and allows early escape of pus and sloughs. If the parts are relaxed and soft no incision is required; but tension is so nearly universal that I am impressed with the value of free early incision, at least in the majority of cases. The creaking as the knife divides the tissues shows the great induration. My opinion does not differ from that expressed under the treatment of boils. Subcutaneous incision is inferior to a direct incision which may or may not be crucial. Capillary hemorrhage may be pretty free, but will relieve engorgement, and is not likely to do harm, even in the asthenic condition

present, unless a vessel of considerable size is wounded. Pressure with compresses and bandages will control such capillary oozing if it is sufficient to require treatment. Applications of very hot water have a styptic influence. Early curetting of the diseased region so as to remove sloughs, pus, and disintegrated tissues seems to me rational. It must be done under anæsthesia, and the cavity made antiseptic. The diseased structures may be destroyed without hemorrhage by the application of caustic potassa, which cauterizes and causes chemical destruction of the skin and subcutaneous tissue.

Thorough cauterization with a red-hot iron thrust through the skin and carried under the skin in all directions may, if used at an early period, destroy the pyogenic organism and prevent spread of the phlegmonous inflammation. It seems to me a valuable suggestion.

Lupus.

Definition.—Lupus, or lupus vulgaris, is a chronic cellular infiltration of the skin, exhibiting itself as irregular, nodular, reddish-brown patches of granulation tissue, which may or may not proceed to destructive ulceration but which usually leave disfiguring cicatrices. Lupus, as previously stated, is probably a form of cutaneous tuberculosis, due to the tubercle bacillus.

Pathology.—The disease has an important surgical bearing, because there is a liability of its being confounded with syphilitic and epitheliomatous ulceration.

The superficial form of lupus, erythematous lupus as it is called, is a very different affection from ulcerating lupus. It is a skin disease located especially in the sebaceous glands and does not interest the surgeon.

Symptoms.—Lupus begins as a group of small, hardened, reddish brown points in the skin which increase until they become papules or tubercles. The patch may enlarge or several small patches may coalesce. There is no pain. Cure may occur at this stage by absorption of the nodules, leaving an atrophic kind of scar; or destructive ulceration of the affected skin may take place. Such ulceration is exceedingly chronic and is characterized by accumulation of crusts, slight discharge, slow involvement and destruction of underlying cartilaginous structures, and contracting cicatrices which cause marked deformity. Ulcerating lupus usually attacks the face in the neighborhood of the mouth, nose, and ears, but may appear upon other parts of the body, especially the fingers. There may be slight pain in the later stages of the disease.

The causation of lupus has been obscure, but is now believed by many to be due to the tubercle bacillus. The general health may be good. It occurs in children chiefly, and is rare in this country, except among the foreign element of our population.

Lupus must be carefully differentiated from syphilitic ulcers and from epithelioma, which shows a predilection to attack similar regions of the face.

Lupous Ulceration.	*Syphilitic Ulceration.*
Comparatively superficial.	Quite deep, often excavated.
Area rather small.	Area may be quite large.
Ulceration usually limited to one region.	Ulcers often disseminated over surface of body.
Increases by coalescing of adjacent patches.	Ulcers remain separate.
Border illy defined.	Border sharply defined.

Lupous Ulceration.	*Syphilitic Ulceration.*
Discharge slight and not fetid.	Discharge abundant and foul.
Scabs thin and reddish-brown.	Scabs thick, often greenish.
Progress slow. takes months to develop.	Progress more rapid, a large ulcer will develop in a few weeks.
Scars hard, yellowish, and have great tendency to contract.	Scars soft, whitish, have little contractile tendency.
No other lesions.	Lesions of bones, glands, etc.
Not improved by medicinal treatment.	Cured by mercury and potassium iodide in full doses.

Lupous Ulceration.	*Epitheliomatous Ulceration.*
Usually upon face, may attack other parts.	Situated usually at muco-cutaneous junctions.
Induration not very marked and is diffuse.	Induration well marked and circumscribed.
No pain.	Pain may be quite severe.
Ulceration begins at several points of the patch.	Ulceration begins at one point and spreads.
Destruction of tissue *usually* not very great.	Destruction and loss of substance great.
No hard and everted border ever present.	Indurated and everted border a characteristic.
Ulcer usually rather superficial, with base of small, red granulations.	Ulcer deep, with uneven base and foul discharge.
Slow in its progress.	More rapid in its progress.
Occurs especially in children.	Occurs especially in adults and aged.

It will be seen that the clinical history of the ulcerative stages of these affections—lupus, syphilis, and epithelioma—are very different. I am convinced that many cases described as lupus have really been epithelioma, for the great destruction of tissue and abundant discharge and pain attributed to lupus are antagonistic to its ordinary clinical features. Rodent ulcer, which is a form of epithelioma, lupus and syphilis, have been confounded by many writers, who have thereby confused the profession.

TREATMENT.—This intractable affection requires active and prolonged treatment. Good, nutritious food, general hygienic measures, and constitutional and local remedies are demanded.

Cod-liver oil (fʒij to f℥ss), iodide of potassium (gr. v–x), and syrup of iodide of iron (fʒss to fʒj) are probably the most valuable internal remedies, and should be tested before severe local applications are adopted. Arsenic is a constitutional remedy worthy of trial. Caustics are necessary as topical remedies, unless absorption of the infiltration occurs in the early stages of the disease. Absorption may possibly be assisted at this time by painting with tincture of iodine, undiluted or mixed with glycerin, or by applying tar or some murcurial ointment, or using iodoform powder. Later it becomes necessary to use caustics to destroy the diseased tissue. Nitrate of silver is highly recommended by Hebra, but it is not as powerful as other agents, which, however, in some instances destroy the healthy as well as the unhealthy skin. Potassa and lime are painful applications, and have a very destructive tendency; hence, the surrounding parts must be protected by pieces of plaster or cloth, and some weak acid should be at hand to neutralize the alkali if necessary. Arsenious acid (gr. xx–xxx to ℥j of ointment) is painful, but acts only on affected structures. Pyrogallic acid ointment (ʒj to ℥j) is painless, and acts very slightly on the normal tissue. Chromic acid, to which a few drops of water have been added, applied with a brush, is my favorite for such purposes. Solution of ethylate of sodium may be

used and is efficacious as a destroyer of abnormal structures. Scraping away the diseased skin with a sharp-edged scoop, or curette, and applying caustics subsequently, such as zinc chloride or one of those mentioned above, is a proper and often an efficient method of treatment. The thermo-cautery, or galvanic cautery, is an available method of obtaining a similar object. Excision of the ulcer may sometimes be justifiable when the gap can be closed by a plastic procedure. Multiple incisions are said to be beneficial by arousing traumatic inflammation.

Arabian Elephantiasis.

Definition.—Arabian elephantiasis, or Barbadoes leg, is a local disease, characterized by chronic hypertrophy of the skin and underlying cellular tissue, giving rise to discoloration, thickening, induration, warty growths and deformity.

It is essentially different from Grecian elephantiasis, or lepra, the Biblical leprosy, which is probably due to a vegetable parasite, the bacillus of leprosy. Leprosy does not belong to the domain of surgery.

Fig. 62.

Arabian elephantiasis.

Symptoms.—The first step in the disease is a local inflammation of an erysipelatous kind, accompanied by involvement of the lymphatic vessels and glands. This attack subsides, leaving the part, usually a leg or the genitals, somewhat enlarged and œdematous. Recurrence of such inflammatory conditions takes place at intervals, leaving in each instance more thickening and deformity. In the course of a year or two the hypertrophied skin and subcutaneous tissue cause the part to assume enormous proportions. The thickened, hardened skin hangs in irregular folds, and the surface often becomes eczematous. From the accompanying fissures and ulcers bloody serum exudes and causes scabs to form. The surface may be smooth and eczematous, or very rough, from the development of papillary enlargements or warts. The enlarged region is usually darker than natural and greatly mis-shapen. The decomposing secretions, if abundant, give rise to fetor. The great weight is a source of inconvenience, and pain or itching may at times add to the patient's discomfort. During

the active inflammatory periods fever is present, and the local symptoms are more severe.

Arabian elephantiasis is not common in the United States, but is frequently seen in the West Indies, South America, and other tropical countries. A condition resembling, if not identical with it, is not infrequently seen associated with chronic leg ulcer. The cause is obscure, but is probably connected with the lymphatic system. The disease is attributed by some investigators to occlusion of the lymphatic vessels by an animal parasite, the filaria. It is found among the poor, especially in adults, and is neither hereditary nor contagious. It is always chronic in its progress, and does not tend to a fatal issue. One of the legs, the scrotum, penis, or vulva is the usual situation of the disease.

Pathologically it consists of an hypertrophy of the skin and areolar tissue, with enlarged bloodvessels and dilated lymphatics. In very protracted cases muscular atrophy and degeneration, and thickening of the bones take place.

Treatment.—It should be treated in the acute inflammatory stages by rest in the horizontal posture, and by cold water and anodyne applications. When these symptoms have abated inunction with mercurial ointment, painting with tincture of iodine, and the application of the elastic bandage are the best methods of inducing absorption and diminution of bulk. Continuous elevation of the limb should always form an important factor of the treatment. The rapid decrease in size under elevation and frequent readjustment of the elastic bandage is often a matter of astonishment, but the hypertrophy is liable to return when the patient regains the erect position. The eczematous complication is often benefited by a paste of salicylic acid (ʒij), carbolic acid (ʒij), zinc oxide (℥ss), mucilage (ʒxx), and glycerin (ʒxx).

Ligation of the main arterial trunk has been followed by amelioration, and Dr. T. G. Morton, of Philadelphia, has reported very favorable results in a case where he excised an inch and a quarter of the sciatic nerve five years after ligation of the femoral artery had been performed with partial success. Amputation may, at times, be justifiable.

Burns.

Definition.—Burns are injuries produced by the application to the surface of heat sufficient to cause inflammation or destroy the vitality of the tissues. Scalds are burns due to contact with hot fluids.

Pathology.—Sunburn is a dermatitis or inflammation of the skin resembling that caused by heat, but due to exposure to the sun's rays. Such inflammation is prevented by protecting the skin with dark veils or clothing, and, when caused, is to be treated as an ordinary burn by cooling and anodyne applications. Injuries due to the chemical action of strong acids and alkalies are improperly called burns, though the effects are similar to those caused by heat.

Injuries from chemicals should be treated locally at first by weak alkaline or acid solutions to neutralize respectively the acid or alkali doing the mischief. The subsequent treatment is identical with that of burns. Lightning and contact with electric light wires sometimes cause burns, in addition to the nervous phenomena due to the electric current. The burns are to be treated as other burns.

The local effects of contact with heat necessarily depend upon the tem-

perature and the time of exposure. There are practically only three classes of burns: 1. Erythematous burns, or those so superficial in their influence that nothing further than hyperæmia and slight serous effusion into the skin occur. 2. Vesicating burns, which do a greater degree of damage, and are followed by vesicles resulting from an effusion of serum between the derma and epidermis. 3. Necrotic burns, which are followed by eschars, because the upper portion of the derma, or, perhaps, the whole thickness of the skin or the muscles, fasciæ, and bones, are devitalized.

SYMPTOMS.—In erythematous burns the skin is red, painful, and swollen; but these inflammatory symptoms subside in a few hours or days, and no cicatrix is left, even when desquamation takes place.

Vesicating burns promptly show vesicles or blebs filled with clear or blood-stained serum, and are the seat of active inflammation causing severe pain. The serum escapes by rupture of the vesicle, or is absorbed, and a new epidermis is formed in the course of a week. If the old cuticle is early cast off or removed by friction, so that the cutis is exposed to irritation and to pus infection from pyogenic germs, in the air or on the clothing, great pain and superficial suppuration result.

No cicatrix follows vesicating burns, though a discolored stain, similar to that often seen after blistering with cantharides, may remain for a considerable period.

Necrotic burns destroy the vitality of the tissues; therefore the eschars, when separated, leave ulcerated surfaces to heal by granulation. The pain of such burns is intense, if shock does not prevent its being felt. The dirty brown color of such burns is characteristic, but it is impossible to tell how deep the destruction has been until the sloughs separate. If the parts are kept aseptic there will be no suppuration under the eschars, which will drop off when the parts beneath are healed. Cicatricial contraction and deformity are usually great. The cicatrices may assume a very rough and irregular appearance from abnormal development of fibrous tissue. Keloid and malignant degenerations at times attack such scars.

The constitutional effects of burns vary with the amount of surface involved and the degree of burning. An erythematous burn of a large surface will cause more dangerous symptoms than a deeper burn of limited area. When burns are severe enough to cause constitutional manifestations, these symptoms are exhibited in three stages: 1, that of shock; 2, that of inflammatory fever; 3, that of exhaustion.

The stage of shock is accompanied by feeble, frequent pulse, great depression of the nervous system, lowered temperature, chills, nausea, restlessness, and perhaps delirium. Pain is not very prominent if shock is great. Greater shock attends burns of the trunk than of the limbs. Congestion of the brain, of the thoracic and abdominal organs occurs, and the patient often dies in twelve or twenty-four hours without showing any reaction from the collapsed state. The degree of shock shown by children and the aged is greater than in the middle period of life.

The stage of inflammatory fever, which lasts from the second to about the fourteenth day, is characterized by increased bodily temperature, disordered secretions, great thirst, and often by inflammation of the internal organs, such as cerebral meningitis, bronchitis, pleuro-pneumonia, and enteritis. It is due largely, if not entirely, to infection by putrefactive and pyogenic germs of the burned surfaces. Ulceration of the duodenum, sometimes proceeding to perforation, is a remarkable lesion occurring at times during this stage. It is to be suspected if hypogastric pain, vomiting of blood, abdominal tenderness, and bloody stools are observed. Its

occurrence has been attributed to the unusual vicarious action thrown upon the duodenal glands, and also to a possible embolic plugging of the vessels of the intestine. Neither of these theories has been proved.

Duodenal ulcer, if it occurs, is developed, as a rule, about the seventh or tenth day of the inflammatory stage. In this stage albuminuria varying with the temperature, and a small vascular eruption thickly scattered over the trunk, have been noticed. Erysipelas may occur.

The stage of exhaustion is due to the depression caused by the inflammatory irritation, and by the profuse suppuration often accompanying the detachment of the eschars and the cicatrization of the resulting ulcers. The suppuration is due to pyogenic infection, which is difficult to prevent when large areas are injured. Infection usually occurs before the surgeon reaches the burned individual. There is great debility but no pain unless the ulcers are subjected to pressure or rudely handled in reapplying dressings. Amyloid visceral changes may possibly result from prolonged suppuration.

Few cases of severe burn, and superficial burns must be considered severe if one-third of the surface is injured, survive until the suppurative stage begins. The majority die of shock within the first thirty-six hours. Many others die during the inflammatory stage from lesions of the internal organs, tetanus, etc. Inflammatory œdema of the glottis from inhalation of steam may be a cause of death; but flame itself is not inhaled, as is supposed by the laity. In most instances where incinerated bodies are found in burned buildings asphyxia has occurred from the gaseous products of combustion before the tissues have been subjected to the action of fire. Spontaneous combustion of the human body is impossible.

Treatment.—The constitutional treatment of burns should be directed to the relief of shock and pain, the prevention of secondary visceral inflammations, and the support of the general powers of the system; while topical remedies should be employed to relieve pain, moderate local inflammation, prevent infection with pus and other germs, hasten cicatrization, and prevent contractile deformity.

Reaction from shock should be sought for by the application of heat and the administration of stimulants and concentrated food in small quantities. The hot bath may be available to raise temperature and relieve pain. In fact, all the measures spoken of in the chapter where Shock after Wounds is discussed are to be employed. Pain is to be relieved in severe cases by an *immediate* hypodermic injection of a quarter or half grain of morphia, or by the inhalation of an anæsthetic. In the later stages of burns laxatives, diuretics, revulsives, and other antiphlogistic measures may be demanded to prevent internal inflammation and to substitute the derivative action of the skin. The stage of exhaustion preëminently requires tonics; and on this account actively depressing remedies are to be avoided in the inflammatory stage.

The local treatment varies with the degree of burn. Erythematous burns, if limited in extent, are relieved of pain by solution of sodium bicarbonate, cold water, lead water and laudanum, and in fact by almost any dressing that excludes air and constringes the dilated capillaries. Menthol or Japanese peppermint might, I think, from its great refrigerant action, be exceedingly soothing. The application of cold to large erythematous burns is ill-advised because of the tendency to depress the surface temperature and congest the internal organs. A household remedy for small burns of this degree is to hold the part near a hot fire

and thus apply dry heat. Zinc ointment spread on cloth, and wheat flour dusted over the burned surface are recommended highly.

The proper treatment for vesicating burns is to puncture the blebs carefully and allow the serum to escape, so as to prevent the epidermis from being rudely rubbed off. This epidermis makes the best possible protection from irritation and septic infection. Antiseptic gauze, or cotton, or some form of dry sterilized dressing should then be applied. Salicylic acid cotton does well. Sublimate cotton would be apt to poison the patient if used for extensive burns. The dressing should not be changed oftener than once in two or three days, because detachment of loosened cuticle and exposure to air increase pain and the liability to germ infection. Antiseptic powders form with the exuded fluids a coating which serves as a good protection from atmospheric influences, and should not be removed until detached spontaneously. Iodoform powder is liable to give rise to toxic symptoms when used in large quantity. Boric and salicylic acids are harmless, or practically so. Much harm is often done by tearing off the epidermis when removing underclothing. It is better, perhaps, in such cases, to leave the soiled shirt or drawers upon the body and saturate it with carbolized castor-oil (1 : 15) applied upon the outside. Three days later, if the patient live so long, less harm will be occasioned by cutting and removing the garments. In this method suppuration is to be expected since infection from the skin and clothing is almost certain.

Necrotic burns require the same line of treatment as vesicating burns, with which indeed they are usually associated. After separation of the sloughs the ulcers are to be treated as previously described under Ulceration. Metallic astringents are often exceedingly valuable to keep down redundant granulations and hasten repair of the breach of continuity. Skin-grafting, in its numerous forms, is often required, and lessens contraction of the cicatrix. Deep burns of extremities may be so destructive to tissue or so threaten life by reason of spreading gangrene, hemorrhage, or violent inflammation that amputation gives the best prospect of recovery.

When possible burned surfaces should at once be rendered aseptic by thorough cleansing and disinfection with antiseptic solutions. To do this etherization and scrubbing the burned surface with soap and a brush may be justifiable if the patient's condition does not contra-indicate. Deaths occurring after the period of reaction are largely due to sepsis.

The greatest ingenuity has to be called into play in the endeavor to prevent cicatricial contraction, which is especially marked when a deep burn has injured the surface of a joint. The irresistible power of the scar contractility everts the margins of mucous orifices, as in ectropium, narrows the outlets of normal canals, flexes or extends joints and renders them immovable, drags features out of position, causing horrid deformity, and binds neighboring members together into one mass. During cicatrization this contraction should be prevented as much as possible by keeping joints extended by splints or by weights applied with adhesive plaster or by elastic bands. Adjacent surfaces should be kept separated by similar measures or by interposed dressings or metallic plates. It must be remembered that two apposed granulating surfaces will readily become connected by union by second intention. In this way several fingers may be united throughout their entire length, if not enveloped in separate dressings. Much can be accomplished by careful and judicious treatment to prevent marked cicatricial deformity; but some disfigurement will often occur despite the best-directed efforts.

Recent cicatrices may be stretched to a certain extent, but old ones usually require operative treatment.

Correction of deformity may at times be accomplished by multiple incision of the scar tissue, or by subcutaneous incisions and unfolding of inodular ridges. Plastic operations are often requisite and gain the desired end by transferring the tension to some neighboring region where the cutaneous structures are sufficiently distensible to allow traction without causing distortion. The various means of transferring tissue by sliding, twisting, and transplanting with and without pedicles will be found under Plastic Surgery.

Frostbite and Chilblain.

Definition.—Frostbite is the injury produced by the application to the surface of cold sufficient to cause inflammation or to destroy the vitality of the tissues.

Chilblain, or pernio, consists in a local paralysis and dilatation of the capillaries of the skin caused by previous frostbite, giving rise to a bluish-red swelling accompanied by great itching and tenderness, and which may terminate in vesication and ulceration.

Symptoms.—When a man is exposed to extreme cold the circulation and respiration become feeble, the limbs stiff and numb, the senses are overcome by drowsiness, and he sinks into a comatose state. If he is not rescued from this condition of apparent death, the fatal issue occurs from congestion of the brain and other organs induced by the contraction of the vessels of the surface. The proper method of restoration is the very gradual application of warmth by means of friction with snow or cold water, followed by removal to a very slightly warmed apartment, and the careful use of stimulants internally and warm embrocations externally. Friction with clothes should also be made in the direction of the venous current. Artificial respiration and other measures should be persisted in for many hours.

It is, however, the local and not the general effects of cold that we are now studying. Frostbites resemble burns, except that their course is slow, and like burns are of three degrees of severity: 1, erythematous; 2, vesicular; 3, necrotic.

Erythematous frostbite follows exposure to a moderate degree of cold and is due to the capillary congestion and slight inflammatory serous effusion that succeed the primary contraction of the vessels. The skin during the application of the low temperature becomes white from deficient circulation, wrinkled and numb; but as soon as return to warmth occurs a bluish-redness, swelling, and tingling pain or itching arise. The equilibrium of circulation is restored gradually and no further pathological changes occur.

When the cold is greater or more prolonged the parts become white, entirely insensible and shrunken, and reaction is accompanied by inflammation, leading to vesication. The vesicles in vesicating frostbite are filled usually with blood-stained serum, and there is danger of gangrene occurring from the violence of the inflammatory process.

Extreme cold devitalizes the tissues at once and they have a mottled appearance from coagulation of blood in the superficial vessels. It is said that the part may be brittle and easily broken, like glass. The necrosed structures are finally separated in the same manner as sloughs

produced by heat or chemical agents. In these cases of necrotic frostbite, as well as in vesicating frostbite leading to gangrene because of active inflammation, it is impossible to tell how much of the tissues is capable of having physiological function restored. Amputation, therefore, must not be attempted in the primary condition of the injury.

The extremities and the peripheral points, such as the ears, nose, and chin, are most frequently frozen, because normal circulation is less active in these localities. For a similar reason persons with weak hearts, and those enfeebled by disease, dissipation, or old age are most liable to suffer from exposure to low temperatures.

Parts of the body subjected to constriction from tight clothing, as gloves, or shoes, or kept in contact with metal are especially apt to be frozen. Cold combined with moisture or wind is more dangerous than cold and dry weather without wind.

Chilblains are local dilatations of the cutaneous capillaries, due to slight frostbites, usually to freezing that has been repeated. The congestion which occurs in these paralytic vessels is accompanied by œdema, bluish-red swelling, severe itching and burning, and occasionally by the formation of vesicles and intractable ulcers. They are most frequent in women and young persons, and those of feeble cutaneous circulation, and give more trouble when the weather changes from cold to warm than when it is continuously cold. When the limbs become warm after going to bed, or when the patient has been indulging in stimulating food or beverages, the itching becomes almost intolerable.

Treatment.—The treatment of all degrees of frostbite should begin by preventing sudden return to normal temperature, because sudden access of blood to the injured capillaries will cause pain and a high degree of inflammation. Hence the parts should never be subjected to heat or put in warm water. The circulation and sensibility are to be restored gradually by friction with articles only a little warmer than the frozen parts. Snow, ice water, and wet cloths are usually employed for this purpose. Afterward slightly stimulating applications, such as alcohol, may be used to complete the reaction. Elevation of the limb and friction toward the trunk may be valuable accessories, because the venous return is thus assisted and congestion in the semi-paralyzed capillaries rendered less intense.

The erythematous, vesicular, and necrotic inflammations that occur after reaction has been established are to be treated very much as burns of similar degrees. Anodyne and cooling lotions or ointments, evacuation of the serum in the vesicles, protection of the skin from atmospheric contact, so as to avoid infection, and moist antiseptic dressings, perhaps, to separate the sloughs, are all indicated in the various degrees of injury. The resulting ulcers are managed as such, without regard to their causation. Amputation is frequently required after severe frostbite, but should not be done until the line of demarcation has been definitely formed. Parts that are insensitive when a needle is thrust into them at the time of freezing, will often have the circulation restored, much to the surprise of the surgeon.

The treatment of chilblains is very unsatisfactory. Tincture of iodine; carbolic acid (1 : 10); carbolized ointment of petroleum; nitrate of silver (1:40); menthol; tincture of cantharides; tincture of aconite root; mustard foot-baths; nitric acid (1 : 30); ammonia; turpentine or camphor liniment; chloroform; metallic astringents and chloral, as lotions or unguents, and similar applications, are to be tried. Tincture of iodine

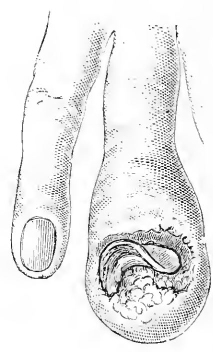
(♏xx), ether (fʒij), collodion (f℥j), may be applied with a brush. Perhaps hypodermic injections of fluid extract of ergot (♏x) or of ergotine (gr. iij) near the seat of pain would be beneficial. All pressure from shoes or gloves aggravates the pain, and should, therefore, be avoided. The ulcers that occur demand treatment calculated to cause healing and to alleviate the itching pain, but care must be observed not to employ remedies that will induce serious inflammation.

Onychia or Onychitis.

Definition.—Onychia, or onychitis, is an inflammation and ulceration of the matrix of a nail of the fingers or toes, by which the nail is discolored and usually loosened, and finally cast off. Onychia must be distinguished from paronchia, or felon, which is an entirely different affection.

Symptoms.—The condition may or may not arise from injury, and is most frequently observed in children as a simple inflammation and suppuration about the root of the nail. The new nail that supplies the place of the diseased one is commonly irregularly developed. At times onychitis assumes a much more serious and intractable form. The ulceration exhibits no tendency to heal, the foul discharge and fungous granulations show the finger or toe to be in an unhealthy inflammatory condition, the end of the member becomes bulbous from morbid deposits, and caries or necrosis of the phalanx occurs. This form of onychia, which is chronic in its course, has been called malignant, and frequently is syphilitic in its origin.

Fig. 63.



Onychitis.

Treatment.—The treatment in simple cases consists of antiseptic lotions and dressings, and anodyne solutions or ointments. The cases depending upon constitutional states require internal remedies, such as iodide of potassium, mercury, and tonics. Locally, cauterization with solid nitrate of silver or nitrate of lead, or the application of iodoform, of nitrate of mercury ointment, or arsenious acid ointment (gr. ij to ℥j) is proper. Scraping away the fungous granulations and irregularly developed nail tissue often assists in effecting cure. Entire ablation of the nail, and even amputation of the finger may become necessary.

Ingrowing Toe-nail.

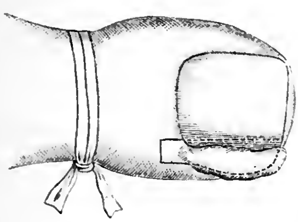
Definition.—Ingrowing toe-nail is a vicious position of the lateral border of the nail in relation to soft parts of the toe, by which the former is buried in, or overlapped by, the latter.

Symptoms.—The malposition of the nail may be due to abnormal curvature of the same, to tight shoes pressing the soft tissues over its border, or to a collection of hardened cuticle under the nail, causing it to assume an unnatural relation to the adjacent structures. The affection is usually seen at the outer edge of the great toe, and becomes in time very painful, because the constant pressure gives rise to inflammation and ulceration

with foul discharge. The corner of the nail may even perforate the substance of the toe.

Treatment.—Palliative treatment consists in allowing the nail to grow forward, and, after scraping away the thickened cuticle beneath, to keep the square corner elevated by a small piece of cotton carefully pushed under it. By a similar piece of cotton or lint the border of the toe should be kept pressed away from the dorsal aspect of the nail margin. The shoes worn must be wide in the sole, be long, and have toes high enough to make no pressure on the top of the nail. The ulceration, if it exists, should be treated with nitrate of silver or nitrate of lead before the cotton is inserted. Salicylic acid (ʒjss), extract of cannabis indica (gr. x), collodion (℥j) make a good application. In inveterate cases the soft parts may be pared away obliquely by an incision beginning as far back as the root of the nail. This fully exposes the ulcer, and by bevelling off the side of the toe prevents the nail irritating the tissues; hence cicatrization and cure usually follow. At times, however, it is better to remove the offending portion of nail. This is done by carrying an incision through the length of the nail, about a quarter of an inch from the edge, beginning far enough up the toe to extend beyond the root of nail. A transverse cut is then made from the upper end of this incision, and a second longitudinal one carried through the inflamed skin in such a manner as to liberate the buried border of the nail. The lateral portion of the nail is then pulled away. The unhealthy and swollen soft parts near the nail are generally also trimmed off.

Fig. 64.



Operation for ingrowing toe-nail. Tape around root of toe to prevent bleeding, and incarcerate cocaine solution injected hypodermically.

The raw surface left by the avulsion is soon healed by granulation under the ordinary dressings for exposed and non-approximated wounds. This is a better operation than removing the entire nail; for, even if both margins have to be cut out, the centre of the toe still retains its covering of nail tissue.

In many cases the surgeon can make his second longitudinal incision run under the skin obliquely and thus free the incurvated margin of nail without leaving so large a surface for granulation. This is a sort of a subcutaneous excision of the nail border.

The operation is practically bloodless if a piece of tape is tightly tied around the root of the toe before the incisions are made. Cocaine solution may be injected into the tissues so as to produce local anæsthesia. Its incarceration by the tape ligature increases the degree of anæsthesia.

CHAPTER XIV.

DISEASES AND INJURIES OF MUSCLES, TENDONS AND BURSÆ.

WOUNDS AND RUPTURES OF MUSCLES AND TENDONS.

INCISED and lacerated wounds of muscles and tendons, if they involve the entire thickness of the structure, are followed by retraction of the cut ends and loss of motion. The treatment consists in relaxing the muscular belly by flexion or extension of the joints, and applying sutures to hold the divided muscular or tendinous structures together.

In suturing tendons it is well to pull down the upper end strongly in order to stretch and paralyze the muscles and then to overlap the ends and stitch them together in that position by longitudinal sutures. If the tendon is wide the suture illustrated in Fig. 50 is a good one. After suturing the limb should be kept for several weeks in the position which relaxes the muscles. This can be done by bandages or the plaster-of-Paris dressing. If the torn belly of the muscle protrudes through a small cutaneous wound it must be pushed back, even if the opening in the skin requires to be enlarged to accomplish this object. Excision of the muscular protrusion is usually improper. If the upper portion of the tendon is so retracted in its sheath that it cannot be pulled down by narrow-blade forceps, an incision upward must be made so that it can be found. A tendon should be attached to a neighboring tendon or muscle when it is impossible to find the two ends of the severed cord. This will prevent entire paralysis of the finger or limb to which the tendon is inserted. Tenosuture and myosuture are often neglected in wounds accompanied by division of the tendons and muscles. In such improperly treated cases the loss of motion may be so detrimental that it is judicious to cut through the cicatrized parts, even after several years have elapsed, and pare the ends of the separated tendon or muscles and suture them properly. As a rule, tendons divided subcutaneously, as in tenotomy, reunite quickly and satisfactorily as to function; but when their surroundings have been freely divided, as in open wounds, good union does not follow unless sutures have been applied to the cut tendons. This is due to the great retraction of the muscular end which occurs in such wounds.

Subcutaneous rupture of a few muscular fibres is not uncommon in severe strains thrown suddenly upon the muscles, and usually is accompanied by sudden, sharp, localized pain and, perhaps, ecchymosis. Rest, the elastic bandage, and massage, supplemented, perhaps, by friction with some sorbefacient liniment is the treatment requisite. The cure is usually somewhat slow.

Complete rupture of the belly of a muscle or of its tendon, either from the bony insertion or at the musculo-tendinous junction, is rather unusual though not rare. Violence, or a sudden powerful muscular contraction, as in tetanus or in the effort to recover equilibrium when about to fall, is the cause of such lesions. When muscles have undergone fatty or other degenerative changes, rupture is possible from very slight strain; but

these tears are unattended by pain, as a rule, and do not concern us surgically. The tendon of the long head of the biceps, that of the calf muscles, and that of the four-headed extensor of the leg are the tendons most frequently torn.

The symptoms of rupture of a muscle or tendon are the occurrence during action of sharp pain, accompanied possibly by an audible snap and associated with almost complete loss of motion, a groove or depression in the surface and, in muscular rupture, ecchymosis. The degree of separation of the ends depends upon the amount of laceration of the surrounding tissues and may be as much as an inch. If the tendon is wide some power of motion may remain because the margin is intact; as in a case seen by me a few years ago, where there was slight extension possible after rupture of the tendon inserted into the patella. Some fibres from the external vastus muscle had evidently escaped rupture.

Rupture of muscles and tendons should be treated by laying open the overlying tissues and suturing the torn structures with chromicized catgut. The limb should then be placed in the posture which tends to keep the extremities of the torn organ near together, and should be so retained by bandages, splints, plaster-of-Paris dressings or by an apparatus of straps adapted to this requirement.

Local weakness remains a long time after union of ruptured muscles and tendons; and the repair that occurs is usually of analogous tissue, which, in the case of tendons, however, finally assumes the characteristics of the original tissue.

Dislocation of Muscles and Tendons.

Dislocation of a tendon occasionally occurs when a sudden strain or twist is brought to bear upon it at a point when its direction is changed by passing around a bony prominence. The long head of the biceps of the arm, the long and short peroneal and the posterior tibial tendons are more frequently displaced than any others. Dislocation of the patella is usually practically a dislocated tendon containing a sesamoid bone.

Reduction is easily accomplished by relaxation of the muscle and pressure upon the displaced tendon, but as the sheath is torn in such luxations, it is difficult to keep the tendon in place after reduction.[1]

Pressure with pads and the elastic bandage will often be effectual, but sudden strain is apt to reproduce the luxation and pain.

Tenotomy may be resorted to in cases of repeated luxation, as has been done by Mr. Bryant. It is possible that some cases might be benefited by open incision, followed by suturing neighboring structures, so as to prevent subsequent displacement.

It is probable that muscles themselves sometimes become displaced from the grooves in which they lie. Such cases would probably be benefited by manipulation, followed by bandaging.

Inflammation of Tendons.

Symptoms.—Tenosynovitis, or inflammation of the tendons and their fibrous and synovial coverings, may be acute or chronic. Thecitis, the

[1] Comparatively little has been written on these injuries, but the reader may find interesting facts in New York Med. Journal, May, 1878, and British Med. Journal, July 13, 1878.

term often used, properly refers to inflammation of the theca or sheath alone, but as both structures are involved in the majority of instances, the word tenosynovitis is a preferable designation of the condition.

Acute tenosynovitis is produced by punctured and other wounds, or may arise without any traumatism, and is usually found affecting the flexor tendons of the fingers or toes. The pain and other inflammatory symptoms, both local and constitutional are very severe, and may terminate in diffuse suppuration, sloughing, necrosis of the phalanges, and septicæmia. The rapid spread of the inflammation to the hand and arm by burrowing of pus along the tendinous sheaths and by gangrenous cellulitis, suggests in many of these cases a resemblance to erysipelas. The severe forms of paronychia, often called whitlow or felon, are usually instances of inflammation of tendons, beginning at the end of the finger. Sometimes the term whitlow is used to signify a mere suppurative inflammation of the cellular tissue of the pulp of the finger-tip, a simple abscess in fact; but the destructive paronychia, which is followed by gangrene and necrosis, involves the tendinous structures and periosteum.

Treatment.—Acute inflammation of tendons demands purgatives, sedatives, and morphia internally, and hot applications and elevation locally, which must, however, be followed very early by free incision to prevent burrowing of pus along the sheaths. A free, longitudinal incision should be practised in the middle line of the tendon, going through the structures down to the bone. This should be done as soon as it is seen that resolution of the inflammation will not occur, and without waiting for the formation of pus. The limb should be kept elevated afterward and enclosed in a moist antiseptic dressing. In whitlow supposed to involve only the structures about the tendon, it has been recommended to incise on both sides of the middle line rather than in the centre of the finger, in order to avoid opening the sheath and thereby allow the suppurative and sloughing action to involve the tendon. My own opinion is that it is not probable that the incision into the sheath adds materially to the risk of the involvement of the tendinous structures, if the incision is sufficiently free to allow all discharges external exit.

Necrosis, subsequent to acute tenosynovitis, may necessitate resection of a joint or amputation of a portion of the finger or limb.

Stiffness or deformity of joints is a frequent sequel of well-treated cases of acute tenosynovitis.

Constitutional diseases, such as rheumatism, gout, and syphilis, are liable to cause inflammation of the fibrous tissue of tendons and aponeuroses, but this is not of the phlegmonous kind, and demands therapeutic management, depending on the cause. Alkalies, salicylic acid, colchicum, iodide of potassium, and mercury are to be administered as indicated.

There is a peculiar form of chronic inflammation of the sheath of tendons accompanied by a characteristic creaking or crackling felt, and sometimes heard, on motion that must be mentioned. This crepitating thecitis usually occurs in the forearm, and seems to be due to roughening of the sheaths by lymph, which causes scraping when the tendons slip in the investing coverings. The inflammation apparently results from long-continued and violent muscular action, or from gout or rheumatism, and is associated with a moderate amount of pain and occasionally with tenderness and swelling. The term "thecitis" is properly applied to this condition.

The crepitation felt when the wrist is firmly grasped by the other hand is characteristic. Its superficial character and occurrence during volun-

tary motion make it very different from the crepitus of fracture. It should be treated by rest, the elastic bandage, blisters, and friction with stimulating liniments.

Deformities from Muscular Paralysis, Contraction, and Rigidity.—Myotomy and Tenotomy.

Pathology.—Any disturbance of the normal equilibrium of the muscular forces gives rise to deformity, hence it is evident that such deformity may be due to increased action of one set of muscles or to impaired power of the opposing group. There are four methods by which muscular distortions occur: 1. Inflammation of muscular tissue (myositis), which is often due to gout, rheumatism, and syphilis, may lead to rigidity and contraction of muscles. 2. Long-continued abnormal position or disuse of muscles, such as result from an unreduced dislocation of a bone, and from inflammation or anchylosis of a joint, may be, and usually is, followed by spastic contraction. 3. Lesions in the nerve centres may give rise to partial or complete paralysis of a group of muscles, and thus allow the antagonistic muscles to exert unrestrained force; or, on the other hand, the central nervous disease may cause such a tonic contraction of certain muscles that their opponents are unable to resist the displacing tendency. In either event deformity ensues. 4. Irritation of the peripheral nerves may, by a reflex influence, cause contraction or paresis of neighboring or distant muscles. Such instances are seen in connection with diseased teeth and gums, and with intestinal and uterine irritation.

Treatment.—The management of deformities arising from abnormal muscular action should differ with the cause of the disturbance of muscular equilibrium. If it is impaired function that causes the distortion the weakened muscles should be strengthened by systematic exercise, electricity, massage, and hypodermic injections of strychnia, and by remedies directed to the promotion of the nervous supply. Brain or spinal cord disease should be sought for and, if possible, removed.

After efforts to strengthen the paretic muscles have proved unavailing, their action may be supplemented by elastic tension or some form of mechanical support. Mechanical appliances tend to do harm if they entirely substitute the action of the weak muscles, because they remove the stimulus to exertion. Hence, the early treatment should be such as will encourage the development of power. If this is found impracticable, mechanical agencies to aid, but not to substitute, are a proper resort.

Muscular contraction from syphilis, gout, and rheumatism can often be relieved by iodide of potassium, mercury, colchicum, morphia or atropia hypodermically, alkalies, massage, Turkish baths, and similar measures. Spastic contraction from cerebral or spinal disease is to be treated by the proper remedies for the lesion there existing; and that due to abnormal position or disuse, by restoring the function to the osseous or other structures primarily involved. Passive motion will often be all that is required to give suppleness to the stiffened muscles around an impaired joint.

Repeated stretching by manipulation, or continuous stretching by weights, elastic extension, or mechanical apparatus adjusted with screws will often overcome muscular rigidity and deformity. The removal of the source of peripheral irritation has often been promptly followed by relief of the muscular contraction or paresis. Tonic spasm of the masseter

muscle has been quickly cured by extracting a wisdom tooth occupying an abnormal position in the alveolus. When the nervous irritation is central and cannot be removed, stretching or excision of a portion of the nerve-trunk supplying the contracted muscle may be useful in curing deformity and relieving the pain which often accompanies the condition of muscular spasm. It is not impossible that cases may occur in which it would be good surgery to trephine the skull and remove the cortical brain centre.

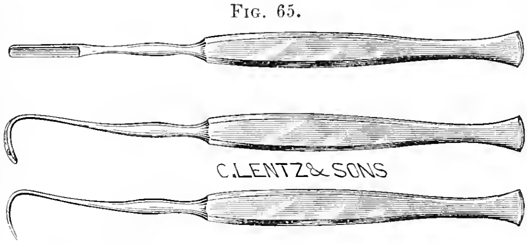
When ordinary measures have been unsuccessful in curing deformity due to muscular contraction the patient should be subjected to division of the displacing muscle. This operation is done subcutaneously and consists in cutting through the belly or tendon of the muscle with a narrow, short-blade knife called a tenotome.

Division of the muscular fibres is myotomy, division of the tendon, tenotomy; but the latter term is sometimes used to include division of muscles and fascias as well as of tendons. It is usually better to cut the tendon than the muscle, if a choice is possible, since the muscular gap is repaired by fibrous tisssue and not by muscle, while the two ends of the divided tendon are united by tissue almost, if not quite, identical with tendinous structure. The operation practically inserts a piece of new tendon in the gap and thus lengthens the muscle. If the tendon is so short as to be inaccessible, the muscular belly may be divided.

Tenotomy should not usually be performed if the deformity depends upon palsy of the opposing muscles, nor if the deformity can be overcome by moderate mechanical power applied by apparatus or by manual force.

In ophthalmic surgery tenotomy is sometimes performed when double vision is due to a strong muscle overbalancing a paretic one.

Fig. 65.



Tenotome with round end and aseptic metal handle.

The tenotome should have a short cutting edge and a rounded end somewhat keen in order to divide the skin, but it should not be pointed. There is then no need of a preparatory incision of the skin with another instrument and no danger of the point injuring vessels. The shank of the knife should be strong, but slender to permit turning in the small wound, and the handle so marked that the position of the cutting edge imbedded in the tissues can be determined. It is usually preferable to divide the tendon by inserting the tenotome under it and cutting toward the surface. This, however, is not a matter of much moment.

The operation is seldom followed by any untoward results. After the edge of the tendon or muscle has been determined by the thumb-nail of the left hand and while the parts are kept stretched and tense by an assistant, the operator slips the tenotome flatwise through the skin and

under the tendon. The edge of the knife is then turned against the rigid cord, which is completely divided by a sawing motion and separates, perhaps, with a snap, so as to leave a distinct gap under the skin. If this springing apart of the ends is not very evident some of the fibres of the tendon have escaped division, or other tendons, or some bands of contracted fascia require section. These must be searched for and cut. Then the knife is turned flatwise and withdrawn. As it is removed the surgeon presses the blood out after it in order that no air may enter the puncture. A gauze dressing is finally placed over the wound, which unites by first intention. The skin and instrument must be aseptic in this as in all surgery.

After tenotomy it is usual to bring the deformed member into good position at once by manipulation and retain it so by appropriate apparatus. Some authorities think it well to wait a few days before attempting restitution of position, but this does not seem to me judicious. The operation is not done to stretch the parts, but to put the foot or limb in proper position and substitute a long tendon for a short one, and the forcible manipulation, if done at once, is painless, because the patient has not recovered from the anæsthetic.

Tenotomy may at times be demanded for the relief of other conditions than spastic contractions, club foot, and similar deformities.

In oblique fractures with great displacement tenotomy may be required to allow proper adjustment of the fragments. The tendon of Achilles is the one that is most likely to be cut for this reason. Recurring painful spasm of muscles about inflamed joints may sometimes justify such a procedure.

In performing tenotomy the vicinity of arteries and nerves must be recollected. The posterior tibial vessels and nerves near the inner border of the tendon of Achilles and the peroneal nerve just inside of the outer hamstring tendon are to be carefully avoided. It is fortunate that when tendons need to be cut they generally stand out in relief because of their tenseness and rigidity.

This prominence can be made more marked by an assistant extending or flexing the joints. Hence, the risk of dividing other structures which are not tense, is reduced to a minimum. Small veins and arteries may be divided with impunity, because the wound is subcutaneous and pressure is readily applied.

Care must always be taken not to puncture inadvertently with the point of the tenotome the skin on the opposite side of the limb. The finger of the surgeon should be kept upon that surface to avert such an accident.

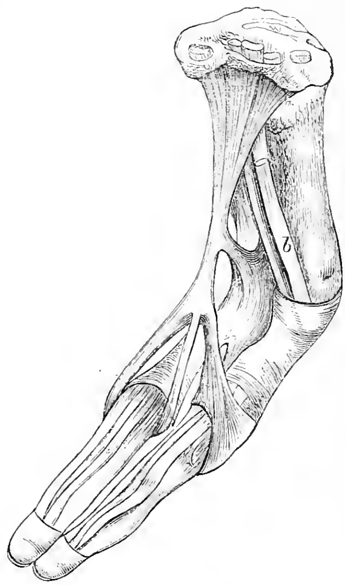
Contraction of the Palmar Fascia and Its Digital Prolongations.

Definition.—This seems to be the proper place to consider the peculiar flexion of the fingers which has been called Dupuytren's contraction. It is a contraction of the palmar fascia and its digital prolongations, not involving the flexor tendons, which is found especially in male patients beyond the middle period of life, and which seems to be associated with and caused by the gouty diathesis.

Symptoms.—The little, the ring, and the middle fingers are most frequently involved, though the other fingers and even the thumb may be similarly affected. The patient notices that during several years a finger

becomes more and more flexed upon the palm, until even forcible extension is impossible and the first and second phalanges are so bent that the last phalanx and nail are, perhaps, pressed against the surface of the palm. This gradually increasing deformity and disability is painless. The neighboring fingers and even one or two fingers of the other hand may subsequently present the same distortion.

Fig. 66.



Dissection of finger contraction, affecting middle and ring fingers. Contracted band of palmar fascia stretches across like string of a bow. Flexor tendons, *b* lying deeply along the concavity of the curve, close to the bones, are bound down along the first phalanges of the fingers by the dense, tubular sheath through which they pass. Digital prolongations extend to articulation between first and second phalanges in each finger. (Adams.)

Examination of the palm shows one or more tense cords or ridges under the skin extending to the sides or middle of the affected fingers. The disease shows a markedly hereditary tendency, and according to recent investigations is evidently of a gouty etiology. Traumatism has been thought to be a cause, but the history of the cases, the hereditary character of the affection, its ocurrence in both hands with almost equal frequency, and its comparative infrequency in females, who are known to be more free from gout than males, make injury a rather improbable etiological factor.

The diagnosis of this affection from stiffness of the fingers due to arthritis or to inflammation about the tendons is readily made. Chronic changes in the skin and joints, preventing perfect extension of all the fingers, is seen in the hardened hand of the sailor and laborer. These conditions are very different in appearance from Dupuytren's contraction of the palmar fascia. The rigid cord or cords extending from the middle of the palm forward upon the sides or middle of the fingers and producing flexion of the first and second phalanges especially, the elevation of the skin over these bands, and the involvement in the great majority of cases of one or more of the fingers of the ulnar side of the hand, point unmistakably to contraction being in the palmar fascia.

A similar contraction of the plantar fascia may occur, but it is very much more unusual than the disease in the hand.

Treatment.—In the early stages of the deformity friction, passive motion, and retention on a straight splint for a long time may prevent the increasing distortion, and, perhaps, restore the function of the finger. As the cases usually present themselves operation and prolonged treatment by splints and passive motion are necessary. The contracted fascia and its digital prolongation should be freely divided by a small tenotome introduced between the skin and fascia at various points. The finger should be at once fully extended and kept in that position by a splint, which should be worn constantly for several weeks. Even after the splint is

dispensed with during the day it should be applied and worn at night. It has been recommended to dissect up a triangular flap of skin in order to cut away the tense fascia piecemeal, but the subcutaneous method of Adams described is usually efficient.

FIG. 67.

Contraction of palmar fascia before operation. (Case from Polyclinic Hospital.)

FIG. 68.

Contraction of palmar fascia after multiple subcutaneous incision.

If the open method is adopted the apex of the flap should be in the palm over the prominent band of contracted fascia, while the base should be made far enough forward on the finger to give access to the median and lateral digital bands, which may extend as far as the second phalanx. After these fibrous ridges have all been clipped away the cutaneous flap is sutured in its former position.

THECAL CYST OR GANGLION.

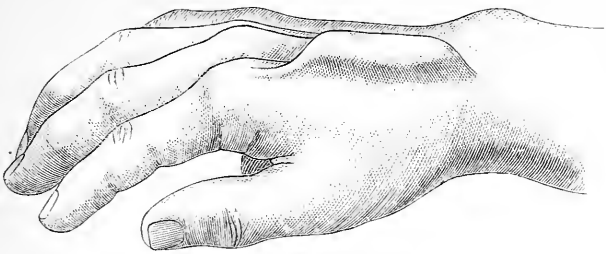
DEFINITION.—The term ganglion is frequently, though ill-advisedly, applied to cystic tumors connected with the sheaths of tendons. This name should be discarded, because it has, in another sense, become so intimately associated with the anatomy of the nervous system.

SYMPTOMS.—This form of cystoma, or cystic tumor, is seldom found except in connection with the tendons about the wrist and ankle. In symptoms and treatment the disease much resembles chronic inflammation of the normally existing bursæ, which will be described hereafter. The cause of these cysts is unknown, though they may be due to strain or some other form of traumatism.

The simple cyst, which is most frequently seen on the radial side of the back of the wrist, occurs as a globular swelling situated over the carpus, smooth, elastic, quite tense, somewhat movable and unaccompanied by

discoloration of the surface. An elongated cyst extending along the sheath of an extensor tendon, such as is shown in Fig. 69, is rare.

Fig. 69.



Cystic tumor of tendon sheath.

There is no pain unless nerve pressure exists, but the tumor causes a feeling of weakness at the wrist. Authorities differ as to whether such cysts are developed upon the sheath of the tendon, or are localized dilatations of the sheath cavity containing the synovial fluid of the sheath more or less altered in character. If formed in the latter way, the orifice of communication probably becomes occluded during the progress of the tumor, for, as a rule, the cyst does not seem to connect with the interior of the sheath.

The compound ganglion, as the other variety is called, is more frequently found connected with the flexor tendons, and is a general dilatation of the sheath cavity, which may involve several tendons. This tumor, though a cystoma, and though called a compound ganglion, has not, as a rule, the multilocular character of compound cysts. The term compound is applied to it rather because of its being a more complicated and more troublesome affection than the simple ganglion just described. It is an irregular, fluctuating tumor, often giving on manipulation a creaking sound and a peculiar crepitant sensation to the finger of the examiner. It contains synovial fluid, which may be dark or bloody, and in which are frequently found floating many small bodies, resembling rice-grains. It is these seed-like bodies which give rise to the crepitation. They are little masses of lymph, probably derived from the cyst wall, which may present a roughened internal surface. The tumor is not painful, but when located in the palm of the hand, its most common situation, causes flexion and impaired motion of the finger. The tumor is not tensely filled, and it is easy to press the fluid from the palmar portion of the tumor upward, under the annular ligament, until the distention is exhibited at the wrist.

Both forms of cystic tumor of the tendons may be found in the foot and other localities. In this connection must be mentioned the fact that in the knee, hand, elbow, and other joints there are occasionally met hernia-like protrusions of the synovial membrane of the joint cavity through the ligaments. These become distended with fluid, and cause some stiffness, though there need be no effusion into the joint proper. Surgical interference with such tumors is very apt to be followed by general synovitis, unless asepsis is rigidly observed.

Treatment.—The localized thecal cyst is treated by sudden pressure causing subcutaneous rupture, or by subcutaneous puncture and discission with a tenotome. The fluid thus distributed through the cellular tissue becomes absorbed. Firm pressure made by the surgeon's thumbs will

rupture the sac unless the wall is quite thick. If this manœuvre does not succeed, it is proper to introduce a tenotome obliquely through the skin at a short distance from the tumor, and then puncture the sac and cut the wall in various directions by means of the single cutaneous opening. The fluid is thus liberated into the cellular tissue, or pressed out through the cutaneous opening, and, as the sac is freely divided, there is little liability of its reforming. The old-fashioned method of striking the tumor with a heavy book is crude, and withal unsurgical, because severe contusions may be caused. The limb should be kept at rest after the operation, and firm pressure made by an elastic bandage, or by an ordinary bandage and compress for several days. The external application of blisters and iodine to such tumors is generally of no service.

If rupture or subcutaneous incision does not cure these simple thecal cysts, and they are the cause of sufficient disability to justify a more extended operation, it is proper to inject tincture of iodine, carbolic acid or other irritating fluid, to lay them open freely, and paint the interior with undiluted carbolic acid, or to excise them.

These procedures are more serious in the order in which they are named, because there is a possibility, though scarcely a probability, of causing violent inflammation of the tendon and secondary impairment of function. If there is no communication between the cavity of the cyst and the sheath of the tendon, this danger is reduced to a minimum, but it is often impossible to distinguish the fact of such absence.

Compound thecal cysts cause considerable interference with the use of fingers or toes, and, therefore, constitute a greater disability than the simple cysts. They are also more serious to treat, because of their free communication with the general synovial cavity of the sheath. Free incision, occasionally in more than one place, with complete evacuation of the seed-like bodies and absolute rest of the part, is probably the best treatment. Some operators prefer to use a trocar to withdraw the contents, and then, after washing out the cavity with antiseptics, inject iodine or some other irritant. As the danger of operation lies in putrefaction and burrowing of pus along the tendons, I am inclined to favor a free incision with aseptic or antiseptic dressings to small punctures or the use of setons.

Inflammation of a Bursa or Bursitis, and Bursal Tumors.

Pathology.—In connection with affections of the tendons, diseases of the vesicular synovial membranes, or sacs called bursæ, must be considered. Bursæ normally exist, as a rule, where a tendon or the integument slides over a bony prominence; but they may become advantageously developed wherever constant pressure and friction call for protection of the underlying structures. The normal bursæ number, it is said, about one hundred and fifty, and are found principally in the extremities. The most important, surgically, are those found over the patella, olecranon, great trochanter, tuberosity of the ischium, and heads of the first and fifth metatarsal bones. The bursal sacs in the popliteal space, under the ligament of the patella, under the psoas and iliac tendons as they cross the pelvic brim, over the acromion, between the angle of the scapula and broad dorsal muscle, beneath the deltoid, and under the four-headed extensor muscle of the leg, should be remembered. Inflammatory affections of these bursæ, though somewhat unusual, are liable to occur, and may

prove confusing to the surgeon. Occasionally a transmitted arterial impulse causes bursal tumors in some of these localities to bear a slight resemblance to aneurism.

Adventitious bursæ are often developed at the points of pressure in club-foot and other distortions, and, indeed, wherever the occupation of the man or woman causes more or less constant pressure.

Bursitis, or inflammation of the bursal sac, may arise from injury or from constitutional conditions, such as gout, rheumatism, and syphilis. The inflammation may be acute or chronic, and may be followed by suppuration or by distention with dropsical effusions.

Symptoms.—Acute is not as common as chronic bursitis. The symptoms are those of acute inflammation limited to the known situation of a bursal sac, with some distention of the sac by increased effusion of fluid. A slight crepitation may at times be felt with the first symptoms of pain before swelling occurs. The immediately adjacent structures are œdematous, and there is often considerable constitutional disturbance.

The sac, when distended with inflammatory fluids, forms a fluctuating tumor. Suppuration may be supposed to have occurred when high constitutional disturbance has persisted for some time, or there have been rigors. The pus may make its exit from the bursa, or suppurative inflammation in the neighboring cellular tissue may occur without actual rupture of the sac until the skin and deep fascia covering the knee, for example, are completely undermined by the burrowing matter. In time neglected cases will point externally, leaving, perhaps, fistulous tracts or ulcerated openings. Sloughing of the tissues overlying a bursa may happen.

Chronic bursitis is more usual, and is characterized by much less pain, perhaps a mere feeling of stiffness or weakness of a limb, and by marked distention and thickening of the sac until a smooth, fluctuating, more or less globular tumor is developed.

The serous fluid contained in the cystic tumor, for such it practically is, may be quite dark from disorganized blood-cells, and frequently exhibits rice-like or melon-seed bodies identical with those described in the section on thecal cysts. The amount of fluid may exceed a half-dozen fluidounces.

Sometimes the walls of a bursa undergo a chronic inflammatory change which, by thickening and deposit of lymph, converts the sac into a hard, fibrous-like tumor, with perhaps a small central cavity.

The most frequent location of bursitis is the bursa lying over the patella, which is frequently subjected to traumatic influences, especially in housemaids and others whose calling requires the kneeling posture. This bursa extends downward over the upper part of the ligament of the patella and thus receives many impacts that the patella itself escapes, for it is well known that in kneeling much of the weight comes in the situation of ligament of the patella and the head of the tibia and not on the patella itself.

Bursitis is to be distinguished from arthritis of the adjacent joint by the localized nature of the swelling and fluctuation, the less interference with motion, the absence of the characteristic semi-flexed position due to synovial effusion in joints, and the comparative ease with which the normal articular prominences can be seen. Synovitis of the knee-joint causes the patella to float upon the effused fluid so that it is raised from the surface of the condyles of the femur. If the surgeon strikes with his fingers upon the skin over the patella he can feel the patella descend through the fluid and come in contact with the femur. This test shows

in cases of inflammation at the knee whether the swelling present is due to fluid below the patella and in the joint or to serous effusion above the bone in the bursa.

Slight inflammation of the joint occasionally takes place as an accompaniment of bursitis because of the proximity of tissues. If the bursa ruptures and allows pus to enter the joint, acute arthritis may readily result.

TREATMENT.—The treatment of acute bursitis should be rest of the limb, accomplished by elevation and splints, and the application of anodyne or refrigerant lotions. Leeches may be of service. In subacute cases or in the earliest stage of acute inflammation a blister may be applied. If suppuration is suspected an early and free incision followed by curetting is proper, because the danger of burrowing of pus and protracted convalescence is great. It is probably preferable in patellar bursitis to make the incision a little to one side of the median line, in order that the cicatrix may not be so subject to pressure after cure has been obtained. Sloughing of soft parts and caries of the patella must be treated on general principles.

If spontaneous evacuation of pus and burrowing have taken place before the case comes to the attendant, the sinuses must be laid open and all pouches must be washed out with betanaphthol or sublimate solution or carbolized water, and emptied by counter-openings or drainage.

Chronic inflammation or dropsy of a bursa is to be treated by counter-irritation and elastic pressure. If this fails, as it usually will, tapping with a trocar or aspirator, followed by the injection of strong carbolic acid solutions or iodine tincture, or by pressure, should be adopted. Laying open the sac and keeping it stuffed with antiseptic gauze, thus causing granulation and obliteration to occur, is an available method. After laying open the sac the interior may be mopped with some strong caustic, as carbolic or nitric acid. Solid bursal tumors must be dissected out. Care is required to avoid injuring the adjacent synovial lining of the joint.

BUNION.

When a normal or an adventitious bursa upon the toes becomes inflamed the condition called bunion is said to exist. Bunions are usually secondary to displacement of and pressure upon the toes, arising from muscular and osseous derangement and the wearing of ill-fitting shoes.

FIG. 70.

Distortion of toe and bunion. (BRYANT)

The metacarpo-phalangeal joint of the great toe is the most frequent seat of bunion. This toe is very liable to a chronic subluxation at this joint, and thus becomes bent toward the middle line of the foot. Upon the prominence made at the distorted joint by the head of the metacarpal bone a bursa is developed by the pressure of the shoe. When this bursa, or the normal one situated nearer the plantar surface of the joint, becomes irritated and inflamed, a bunion exists.

It is said that this deformity of the great toe is due to wearing narrow and short shoes, but this is probably untrue, since marked subluxation is exceedingly common in the lower classes, who do not take pride in exhibiting small feet. A more probable explanation is that of Key, who believes it due to exces-

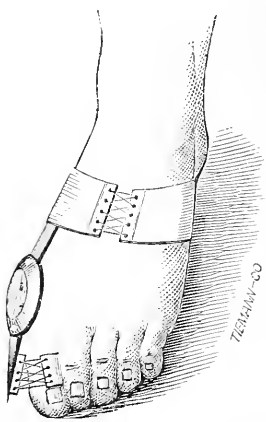
sive standing which, when the arch of the foot is weak, causes distortion because of the obliquity of the pressure upon the inner side of the sole.

Tight shoes cause the development and the inflammation of the bursa, and thus lead to the bunion, but probably do not act as the primary cause of the deformity.

Club-feet usually have bursæ developed upon their prominences, but even if these bursæ imflame they are seldom dignified by the special title bunion.

The skin over a bunion may have a corn developed upon it, which, of course, increases the painfulness of the affection. A bunion may suppurate, leaving a foul ulcer or fistulous opening; may open into the joint cavity, causing arthritis and disorganization of the articulation; or may, in decrepit patients, be the starting-point of erysipelas or gangrene. The preventive treatment of bunion consists in maintaining the correct axis of the toe, and restoring it when deflection first occurs. The first is to be done by avoiding continuous standing during youth, and wearing shoes with flat heels and broad soles, and almost straight along the inner edge. The true Waukenphast pattern fulfils these indications. Restoration of a distorted toe may be accomplished by steel springs and elastic traction, so arranged as to be worn constantly.

Fig. 71.



Bigg's apparatus for replacing toe.

Tenotomy of muscles which act as displacing causes, division of the ligaments, excision of the joint, or amputation of the toe may be justifiable if the deformity and the resulting inflammation and necrosis cause great disability.

The bursitis must be managed by rest, elevation of the foot, anydyne lotions, painting with nitrate of silver or tincture of iodine, and the local and general measures detailed in the chapter on Inflammation.

The formation of pus requires an incision, but in all operations in this region in old and debilitated patients it must be remembered that the circulation here is feeble, and that unhealthy inflammation and gangrene are not unusual after surgical interference. The treatment of bunion, then, is identical with that of inflamed bursæ elsewhere.

A radical cure can sometimes be effected by introducing a tenotome at a distance and cutting up the bursal sac, as is occasionally done in thecal cysts. Laying open the sac by a free incision or excising it may at times be justifiable operations.

CHAPTER XV.

DISEASES AND INJURIES OF THE NERVOUS CENTRES AND NERVES.

DISEASES AND INJURIES OF THE BRAIN.

Meningocele and Encephalocele.

THESE are congenital tumors due to the protrusion of a portion of the meninges in the one case, and of a part of the encephalon and its coverings in the other case, through an opening in the cranial bones. The protrusion may occur at a suture, a fontanelle, or an abnormal orifice in the skull. The most common seats for such unusual tumors are the occipital and frontal regions. In pathology these tumors resemble hydrorachis or bifid spine.

FIG. 72.

Meningocele.

A meningocele being a pouch of brain-membranes containing sub-arachnoid fluid, resembles a cystic tumor of ordinary kind.

Encephalocele is often associated with other congenital malformations, and usually is more solid than the tumor just described.

As a fatal issue generally occurs in these congenital hernias of the brain and its membranes, encephalocele and meningocele are of little importance except that the surgeon must think of them when diagnosticating tumors of the head.

Their partial or complete reducibility, their immobility, the location of the neck of the tumor upon the cranial bones, the variation in distention as the child is quiet or excited, and in encephalocele, the occasional existence of pulsation, will aid in the diagnosis.

Pressure, aspiration, ligation, and excision are methods of treatment indicated, but are in most instances valueless.

Hydrocephalus.

Hydrocephalus is a dropsical condition of the brain, consisting of an abundant accumulation of serous fluid in the ventricles or the arachnoid space, or in both. It is a chronic condition, usually occurring as a congenital disease. Acute hydrocephalus, so called, is of different pathology, for the term is variously applied by authors to tubercular meningitis and to cerebral dropsy due to renal disease. The amount of fluid in chronic hydrocephalus varies from half a pint to several pints, and produces enlargement of the head, especially in the antero-posterior diameter,

spreading of the sutures and thinning of the cranial bones. The peculiar squareness of the cranium and relatively small face give the child a characteristic appearance. The intracranial pressure and want of brain development cause lack of intelligence, paralysis, convulsions, retinal changes, and other cerebral symptoms. There is apparently little pain felt by the infant.

The most improved remedies are mercury and iodide of potassium, which have at times seemed to yield good results. Early death follows hydrocephalus, as a rule, when the dropsy is great and situated in the ventricles. Dropsy located in the cerebral membranes has a more favorable prognosis.

Tapping the distended skull with the aspirator, whether or not followed by injections of dilute tincture of iodine, has not been very satisfactory. It is better to repeat the tapping than to attempt to evacuate all the serum at once, and the fluid should each time be drawn off slowly. The instrument should not be introduced in the median line of the sagittal suture because the superior longitudinal sinus would be punctured. The wide separation of the bones gives opportunity to pierce the cranium at one side of the median line. Moderate pressure by an elastic bandage may be employed after tapping, or even as an independent treatment.

If convulsions occur during the progress of the disease, bromide of potassium is the proper remedy.

Intentional puncture of the ventricles themselves has been done by Keen in a case of hydrocephalus. Death finally occurred after apparent benefit from the operation.

Inflammation of the Brain from Surgical Causes.

Varieties.—Inflammation of the cranial contents is termed encephalitis. The pathological process may be located in the meninges or membranes (meningitis), in the nervous tissue composing the various parts of the brain (cerebritis), or may involve both structures (meningo-cerebritis).

These three conditions, therefore, are merely varieties of encephalitis or intracranial inflammation. It is rare to find severe meningitis without some involvement of the underlying brain substance; and, unless the cerebritis is limited to the deep parts of the brain, local meningitis, at least, is a usual accompaniment of inflammation of the nerve tissue. Cerebritis strictly should not include inflammation of the cerebellum, to which the term cerebellitis ought to be applied.

Pathology.—In meningitis inspection of the membranes shows vascular engorgement of the dura mater and pia mater, cloudiness or opacity of the arachnoid, and greenish or yellowish lymph deposited upon and between the membranes. The arachnoid membrane and its cavity show with most frequency the existence of pathological changes; but puriform lymph and pus will be found smeared upon the dura mater or in the meshes of the pia mater if the inflammation reaches a high grade. The relative position of these morbid deposits, as to the dura and pia mater, depends much upon the starting-point of the encephalitis. Thickening of the membranes occurs with the progress of inflammation. Cerebritis, and the term is used to signify inflammation of the cerebellum and pons as well as of the cerebrum, is exhibited by increased vascularity, a change in color from gray or white to a pinkish or dirty yellow or a leaden hue,

turbid serum in the ventricles, and softening of the nerve structure. If the disintegration continues pus will be formed, constituting a cerebral abscess, which may contain several fluidounces of fluid.

Causes.—The causes of surgical encephalitis are fracture, caries, and necrosis of the skull involving directly or indirectly the cranial contents; wounds of the membranes; concussion, contusion, lacerations and other wounds of the brain; and pyæmia.

Symptoms.—The symptoms of meningitis and of cerebritis are not, as a rule, sufficiently distinct to make a differential diagnosis possible. Fortunately, their treatment would be identical in the majority of cases, even if such a diagnosis was made. Acute traumatic encephalitis gives rise to headache, pain, and elevation of surface temperature at the seat of injury, contracted pupils, intolerance of light and sounds, restlessness, delirium, general fever, full and frequent pulse, constipation and perhaps vomiting. As the disease progresses twitching of the muscles, strabismus, convulsions, stupor increasing to absolute coma, and relaxation of the sphincters of rectum and bladder supervene. Great circulatory depression, as shown by feeble, irregular, and very frequent pulse, clammy sweating and dilated pupils proclaim serious involvement of the brain, which will, in all probability, speedily terminate in death. The paralytic symptoms are due usually to the exudation of inflammatory products, which cause a condition similar to compression from extravasation of blood in depressed fracture. Rigors occasionally happen and suggest the formation of an intracranial abscess or of pyæmic infection from inflammation having involved the diploic structure of the cranial bones. Subnormal temperature is thought to be indicative of abscess.

Acute encephalitis occurs in from one to three days after the receipt of injury, and usually leads the surgeon to believe that there has been a general injury to the brain in addition to the evident local lesion. In other words, symptoms of acute encephalitis generally mean contusion or laceration of one or more parts of the brain distant from the point of impact with the vulnerating body. Laceration by counter-stroke at the side opposite the injury is a not unusual factor in the etiology of acute inflammation.

The condition occurring after injuries and called irritation of the brain is probably a minor degree of encephalitis affecting special regions of the brain substance. It is characterized by restlessness of the patient, who lies curled up on one side with his limbs flexed and his eyes tightly closed. If aroused from his semi-insensibility he shows a momentary mental irritability, and then relapses into a restless sort of sleep.

Chronic encephalitis causes headache, vertigo, hebetude and intellectual dulness, insomnia, epileptiform seizures, choking of the optic disks or papillitis, paralysis, and coma. The symptoms are less violent than in acute inflammation, but are similar, though coming on insidiously and at a period varying from weeks to months. Pain at the seat of injury and a local rise in surface temperature are grave symptoms in old head injuries.

Death occurs in encephalitis from pressure due to morbid deposits or from blood extravasated from diseased vessels; from destruction of nervous centres by softening or abscess; from interference with blood-supply by thrombosis, and from pyæmic injection of the general system.

A diagnosis between meningitis and cerebritis is, as a rule, impossible, because the two conditions are so frequently associated that we are not assured of the symptoms pertaining exclusively to each. If the local pain,

the restlessness, nausea, and hyperæsthesia of the optic and auditory nerves are especially marked, it is probable that inflammation of the meninges is the prominent pathological change. Cerebritis is to be suspected if convulsions, jerking of the muscles, trembling, and sudden disturbances of the special senses are observed. The suspicion is strengthened if the muscular symptoms are unilateral, and if coma and actual paralysis of one side rapidly occur.

Treatment.—Acute inflammation of the brain requires active treatment. The entire scalp should be shaved to permit full examination for fracture, contusion, or other injury; the head should be elevated, cold should be applied to the cranium by means of a bladder or rubber bag containing cracked ice, or by means of cold water passing through a coil of tubing encircling the head several times, and the patient should be kept in a darkened and quiet room. If the pulse is hard and frequent, the face flushed, and the carotid arteries evidently carrying a large amount of blood to the head, venesection at the bend of the arm is valuable. The bleeding should be supplemented by free purging, large doses of bromide of potassium (ʒiij to ʒv in twenty-four hours) and cardiac depressants, such as tincture of aconite root (♏j to iij every two or three hours), or tincture of veratrum viride (♏j to iij every two or three hours). The best purgatives are calomel and jalap (gr. v to x each), or two or three compound cathartic pills. Many do not require bleeding, but are judiciously treated by the other remedies mentioned, with or without wet cupping at the nape of the neck. Digital or instrumental pressure upon the carotid arteries has been suggested as a means of diminishing the intracranial circulation. Some high authorities advise the use of mercurials and opiates to combat encephalitis, and give calomel (gr. $\frac{1}{4}$) and morphia (gr. $\frac{1}{12}$) every few hours, for their antiphlogistic and quieting effect. I have been accustomed rather to rely upon the revulsive action of purgative doses of mercury and other drugs, and the cerebral anæmia and quiet produced by large doses of bromide of potassium. When there are great restlessness and brain irritability, morphia in moderate doses is indicated. Chloral (gr. v to xv) or hyoscine hydrobromate (gr. $\frac{1}{100}$) may be employed to meet this symptom. The diet should be limited in quantity, and restricted to milk or other non-stimulating food.

In the later stages, when exudation has probably occurred, blisters may be used locally, and iodide of potassium (gr. v to x) and mercury (green iodide, gr. $\frac{1}{6}$ to $\frac{1}{3}$) given internally several times in the twenty-four hours.

When great depression supervenes some alcoholic stimulant may be employed, but usually this stage presages death, which cannot be, and perhaps could not, have been averted. In all cases the bladder should be watched, and catheterized if the urine is not passed. The patient is perhaps unconscious, and the attendants may neglect to call attention to the fact that no urine has been passed unless the surgeon makes inquiries.

Subacute and chronic encephalitis demand similar though less active treatment. The measures mentioned for the later stages of the acute disease are especially applicable. Mercury, iodide and bromide of potassium, blisters, and laxatives are usually employed. If an acute inflammation is engrafted upon a chronic one, it must be met by active and vigorous measures, as though it had been an acute affection primarily.

In all cases of suspected brain disease the condition of the urine should be investigated, since renal changes will induce uræmic symptoms, simulating intracranial inflammation.

Patients who have recovered from encephalitis due to surgical causes,

may suffer for many weeks from vertigo, headache, sleeplessness, mental aberration, and other sequels pointing to deranged nervous activity. These symptoms are to be combated by the long-continued use of alteratives, such as the preparations of mercury and iodine, and by the temporary administration of bromide of potassium, chloral hydrate, and similar medicines.

Chronic encephalitis is a not uncommon symptom of tertiary syphilis, and is frequently associated with syphilitic inflammation of the spinal cord. Mercury (green iodide gr. j to gr. ij, during twenty-four hours), with iodide of potassium (gr. lxxv to gr. c in twenty-four hours), is especially indicated in such cases. All chronic cases should be subjected to antisyphilitic treatment, as should all cases of supposed brain tumor.

Operative Treatment.—When it is possible to locate the exact seat of the intracranial inflammation, operative interference may sometimes be undertaken with the hope of removing the spicule of bone or the foreign body which has caused and is keeping up the morbid process, or with the expectation of evacuating the collection of blood or pus which is threatening the life of the patient.

Trephining the skull, incising the membranes and puncturing the brain tissue are the modes of operation that may be adopted. Such procedures are much more frequently justifiable in chronic than in acute encephalitis, because the former is more likely to be local in its causation and in its lesions, and, therefore, more accessible by operation. The reader must recollect that in this connection I am speaking of trephining as a mode of treating *existing* traumatic inflammation of the brain, and not of preventive trephining, which is undertaken to prevent the consequences of punctured and other forms of fracture of the cranium. The method of using the trephine will be described under fractures of the skull.

Operation may be done to give exit to an extravasation of blood or a purulent collection within the cranial cavity; to remove a foreign body, such as a bullet, supposed to be buried in the brain or membranes, and to endeavor to find and get rid of the cause of an inflammation which is suspected to be due to a splintered condition of the inner table or to localized bone disease.

Collections of pus or of blood may lie between the bones and membranes (subcranial), in natural or abnormal cavities formed between layers of membranes (intermeningeal), or in the substance and ventricles of the brain (cerebral). Subcranial and cerebral extravasations and abscesses are usually circumscribed, and, therefore, more amenable to operative treatment than intermeningeal collections, which are, as a rule, diffused.

Localization of Brain Lesions.—Until within a few years the surgeon had little to guide him in attempts at ascertaining the precise location of cerebral lesions; and, therefore, operations upon the skull and brain were seldom justifiable in cases where there was no fissure or opening in the cranium. A localized puffy swelling of the scalp, or separation of the pericranium exposing yellowish or dry bone, with hemiplegia of the opposite side of the body, and especially if rigors had occurred, might induce a bold operator to trephine and endeavor to evacuate the abscess; but there were no rules founded on physiological and clinical observation to guide him in the less obscure cases.

The recent study of cerebral localization by Ferrier, Charcot, Horsley, and other neurologists, however, has made it possible to determine the site of many lesions of the cerebral cortex, or surface, by the local temperature and the character of the paralytic and other nervous symptoms.

The special symptoms belonging to irritative and destructive lesions of the various parts of the interior of the brain have not yet been established with much accuracy; and, indeed, the exact locality of many of the nervous centres upon the surface is still doubtful. Nevertheless, enough has been done in this direction to aid the surgeon very much in determining, from the symptoms, where to apply the trephine in suspected abscess, extravasation, or impacted splinters of bone.

Fig. 73.

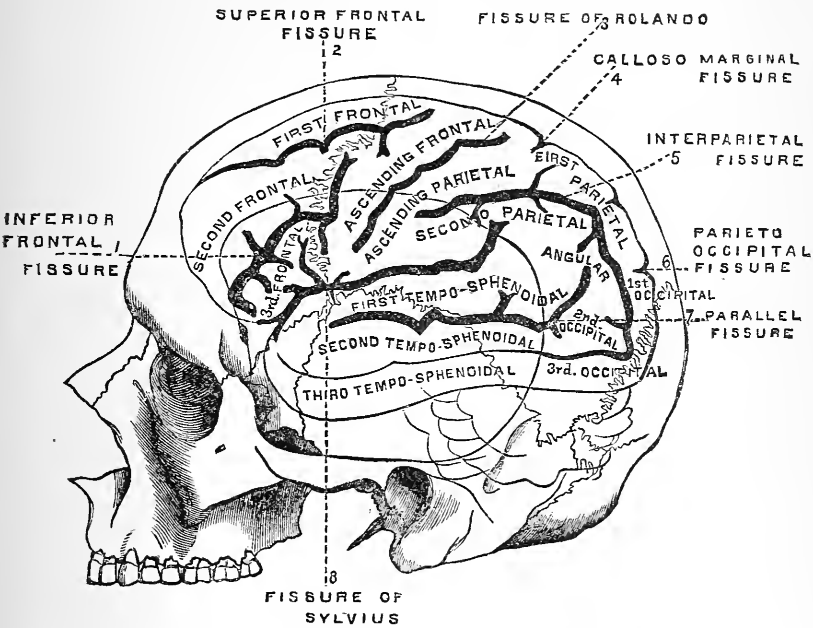


Diagram of skull, showing relation of convolutions to bones.

The relation of the important landmarks of the brain to the external conformation of the skull is found in the figures.

It is important to distinguish lesions of the surface of the cerebral hemispheres from those of the interior of the brain, because the former, unless at the base, are more easily reached by operation. Cortical lesions cause usually not a loss of motion of an entire side (hemiplegia), but a paralysis of only a special group of muscles, as of the hand, forearm, or leg (monoplegia), and there is quite frequently *early* rigidity of the same muscles. Jacksonian epilepsy, or convulsive action of a single group of muscles, as of a thumb, occurring alone, or occurring as a prelude to a general epileptiform convulsion, gives indication that there is a lesion of that particular cortical centre, and points to the advisability of an exploratory operation in that region. Local pain, which may be felt only when the head is percussed over the lesion, is also a symptom of cortical disease, and, finally, unconsciousness is not so often associated with the paralysis from cortical lesions, as is the case in paralysis from lesions of the central portion of the brain.

The portions of the cortex in which the nervous centres of motion are located are the bases of the three frontal convolutions, the convolutions

along the fissure of Rolando and the paracentral lobule, while the centres of sensation seem to be in the parietal, temporal, and occipital lobes of the cerebrum. Recent investigations go, however, much further than this, and locate with considerable certainty centres governing many special motions. From this knowledge it is possible to diagnosticate with a great degree of certainty the location of the inflammatory process which is producing the symptoms in a given case.

Fig. 74.

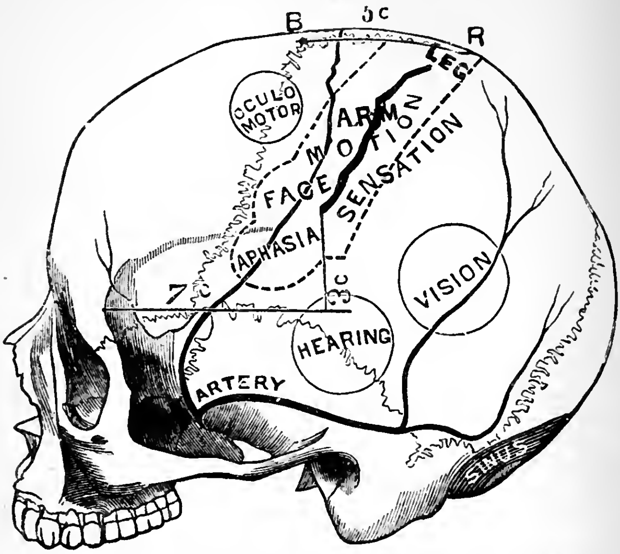
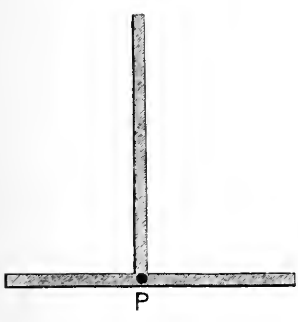


Diagram of skull, showing lines of fissure of Rolando, middle meningeal artery and cortical centres.

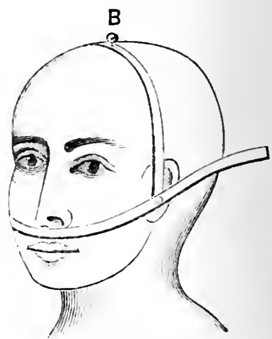
The symptoms pertaining to lesions of limited areas still require further differentiation, but the value of cerebral localization to surgical treatment

Fig. 75.



Broca's square.

Fig. 76.



Broca's square applied.

has so rapidly increased that even now it is incumbent upon all surgeons to recognize its utility. As an example, let me state that paralysis of an arm

alone (brachial monoplegia) indicates disease of the upper part of the ascending frontal convolutions of the opposite side. Here then would be the place to trephine, if the other symptoms rendered the occurrence of abscess or intra-cranial bleeding probable.

It is always important to determine upon the shaved head the location of the fissure of Rolando before undertaking any operative procedure based on cerebral localization. This may not be necessary if an external injury or scar indicates the probable seat of lesion. This fissure has its upper end 50 or 55 millimetres behind the bregma or junction of the interparietal and coroneal sutures, but does not quite reach the middle line of the skull. The bregma is found by drawing a vertical plane through the two external auditory openings. The lower end of the Rolandic fissure is about six centimetres above and a little behind the external auditory canal. It makes an angle of 67 degrees with the median line drawn from the glabella, or smooth spot at the root of the nose, to the external occipital protuberance, or inion, and has its upper end beginning on a line with a spot situated $55\frac{7}{10}$ per cent. of the total distance from the glabella to the inion. The illustrations show two methods of determining the location of the Rolandic sulcus: that by Broca's square and that by Wilson's cyrtometer.

FIG. 77.

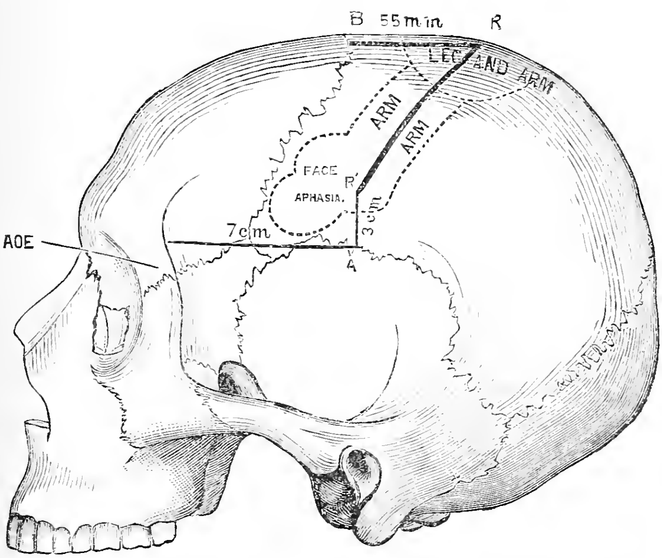


Diagram showing one method of locating the fissure of Rolando. (NANCREDE.)

Some general rules may be formulated that are well worth attention.[1]

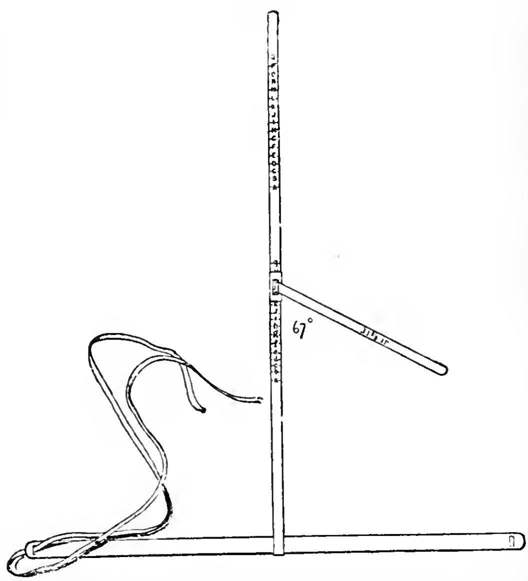
In injury or disease in the neighborhood of the fissure of Rolando, which is the motor region, operation is indicated when monoplegia is present, except when anæsthesia accompanies the paralysis of motion; then it is contraindicated, because the lesion is evidently so extensive

[1] See Operative Surgery of the Human Brain, by John B. Roberts. Also papers of C. K. Mills and Roswell Park in Trans. Congress of American Physicians and Surgeons, vol. i. 1889.

that sensory as well as motor centres are involved. When paralysis or convulsive movements occur in connection with disease of the sensory region, operative interference is improper, since the pathological change is not limited to the sensory centres, but involves the motor region. An exploratory trephining, if properly carried out with antiseptic precautions, is so devoid of danger that many surgeons would operate notwithstanding the co-existence of motor and sensory symptoms.

Paralysis on the same side as the injury of the head should be considered an indication against operation at the point of injury, because there is probably a lesion at the opposite side of the brain, due to counter-stroke. Again, very profound loss of motion points to non-interference, because it is likely that the injury involves deeper tissues than the cortical centres of motion. Paralysis of the cranial nerves, Cheyne-Stokes respiration, choked disk, and symptoms referable to injury of the base of the brain contra-indicate surgical procedures.

FIG. 78.



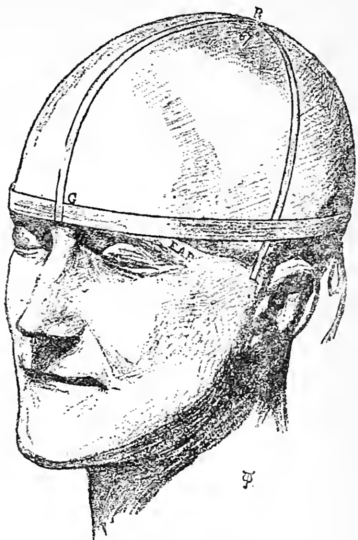
Wilson's cyrtometer, consisting of a steel tape to encircle the cranium and sliding upon it another tape making with it an angle of 67°. Both tapes are marked with a scale. (PARK.)

The occurrence of aphasia betokens an abscess, pressure from a clot, or injury from a spicule of bone, located near the base of the third frontal convolution and the island of Reil, and usually on the left side. Right-sided loss of motion in addition to the aphasia, while showing a more extensive lesion, perhaps, fixes the lesion at the left side of the brain. In such cases trephining gives a reasonable hope of reaching and removing the cause of the threatening symptoms.

When the symptoms and principles just discussed furnish sufficiently clear evidence to satisfy the surgeon as to the probable seat of the lesion,

it is proper, if the case present a serious outlook, to trephine without delay. Delay is dangerous if the lesion is chronic encephalitis with abscess; and equally so if there are symptoms of a large extravasation of blood, or of a local inflammation due to spicules of bone. After the skull has been bored the pus or blood will be evacuated if it lies between the bone and dura mater. If none is found, and the dura bulges into the opening and does not show pulsation an incision should be made through this membrane with the object of reaching any collection beneath it. If the symptoms of cerebral abscess have been very characteristic and death is imminent it is justifiable to puncture the brain in various directions with an aspirator needle or grooved director in order to reach the purulent deposit. In the event of discovering a large hemorrhagic effusion from a meningeal vessel, torsion of the artery may be required. If this fails a trephine may be again applied over the course of the vessel, and a ligature applied after removal of the disk of bone. After reaching an abscess of the brain the surgeon must be on the alert to keep the orifice open and not let it become closed by granulations. Injections of carbolized or other antiseptic solutions into the abscess cavity and the use of drainage-tubes will contribute to the successful treatment of such cases. There are now on record numerous instances of trephining and brain puncture for extravasated blood, cerebral abscess and for the removal of brain tumors, which have been followed by recovery.

Fig. 79.



Cyrtometer applied, showing *G*, glabella, *R*, junction of line of Rolandic fissure with median line from glabella to inion. (Park.)

Injuries of the Brain.

Under this heading I shall discuss wounds, concussion, and compression of the brain, leaving fractures of the skull to be treated in the chapter on Diseases and Injuries of Bone.

Scalp Wounds.—It is usual for writers to devote a section or two in this connection to descriptions of scalp wounds. The proximity of the brain to the part wounded and the possibility of the vulnerating force having fractured the skull or caused brain injury at the time the scalp wound was inflicted should make the surgeon cautious in watching symptoms and careful in the treatment of scalp wounds; but there is nothing intrinsically special in such injuries. They should be rendered aseptic and be approximated by sutures, and their complications, such as hemorrhage, abscess, and erysipelas met as in ordinary wounds. The pin suture is a favorite of mine as it controls the bleeding, which is apt to be profuse because of the great vascularity of the scalp. It is easy, however, to con-

trol hemorrhage by a tight bandage around the head, for the cranium gives a firm surface against which to make pressure.

Wounds of the Brain.—Wounds of the brain are usually accompanied by fracture of the skull. Such is not the case, however, when laceration from sudden jarring occurs, or when punctures are received through the fontanelles or other openings in or between the bones. Wounds of the anterior and superior region are less serious than those of the base or posterior part of the encephalon. Very serious wounds result when fragments of a fractured cranial bone are driven into the meninges and brain substance. Gunshot wounds are also very destructive.

The symptoms of brain wounds depend upon the situation of the injury and the amount of nervous tissue involved, as is easily understood from the foregoing remarks on cerebral localization. Shock, paralysis, and perhaps unconsciousness, in varying degrees, are the early symptoms of brain wounds, and are soon followed by local or general inflammation of the brain. Portions of brain material may be cut off by the surgeon or carried away by extensive injury and recovery be not only possible but even probable if the parts are kept or soon rendered aseptic.

Treatment.—The treatment of brain wounds is embodied in two precepts: Remove the foreign body, if any exists and it can be withdrawn without inflicting grave additional injury; and prevent, or at least limit, the secondary inflammation that is liable to follow the wound, by antisepsis and most thorough drainage.

Probing brain wounds to discover the locality of a bullet or any missile should be done only with great care and with aseptic precautions. A large-headed probe of aluminium is the best instrument and should be allowed to follow the bullet-track by its own weight when the patient's head is so placed that gravity will carry the probe in the course of the wound. Trephining to give access to the foreign body is proper, and thorough drainage by means of rubber tubes is essential to cure. Measures calculated to combat encephalitis should be employed. Secondary abscess must be diagnosticated and treated as described in the section on cerebral inflammation. Recent observation has shown that the brain can be punctured, incised and excised with a great degree of impunity, provided the internal ganglia are undisturbed and these operations are rigidly aseptic.

It occasionally happens that through the opening in the membranes and skull there occurs during the progress of inflammation a fungoid protrusion of brain matter mingled with lymph, pus and blood. This constitutes the condition called hernia, or fungus, of the brain, which is liable to continue until either exhaustion or the damage done the nervous centres by inflammation causes a fatal issue.

Fungus of the brain demands no special line of treatment; but cleanliness in removing the discharges and the use of antiseptic dressings are proper. Moderate pressure upon the mass may be attempted, but it is liable to do harm by causing retention of the secretions within the cranial cavity. To cut off the protuberance is not infrequently good surgery.

The possibility of fungus of the brain occurring must be remembered when operations are performed which are liable to divide the dura mater; hence, the dura mater should be carefully sutured after the removal of tumors of the brain. It is understood that provision for drainage must be made through the dural incisions, by tubes, or strands of catgut or horsehair.

Concussion, Contusion, and Laceration of the Brain.

Definition.—The term concussion has long been used to designate the symptoms which follow vibration of the brain consequent upon blows received directly upon the skull or transmitted there through the spinal column. It was supposed that a man might die instantly from concussion of the brain, without receiving any physical lesion of the brain substance.

Pathology.—This assumption I believe to be false, for fatal cases of so-called concussion of the brain exhibit, on careful examination, contusion or laceration of the brain, separation of the dura mater from the bones, compression from clot, or some distinct lesion of the contents of the cranium. Death in cases in which no such evidence of brain injury has been found, has not infrequently been attributed to concussion of the brain, without an investigation of the spinal cord and heart. Fatal changes would probably have been found there. I admit the *possibility* of the vibration causing a molecular change in the nervous cells, the capillaries, or the cerebro-spinal fluid, which could not be appreciated by our ordinary methods of investigation, and which still might be capable of producing the symptoms found in slight concussion; but when death occurs in cases denominated concussion of the brain, I believe that distinct lesions, if carefully sought for, will always be found.

If a vessel containing jelly, of the consistence of the brain and containing similar cavities, was forcibly struck, fissures could easily be produced in the mass by irregular transmission of the vibrations of force. So, I believe, do lacerations and contusions of the non-homogeneous brain occur.

In my opinion, then, concussion of the brain is not a functional condition, but is used to designate organic changes. The term, therefore, should be discarded for contusion or laceration.

Cases of slight concussion very much resemble a similar degree of that obscure condition called shock. It is, perhaps, possible that a sudden moderate force applied to the head, containing cerebro-spinal and sympathetic nerve centres, causes pallor, vertigo, and confusion of ideas by the same pathological change that occurs when peripheral nerves are injured.

When greater violence is offered to the brain it is to be expected that, in addition to the condition of shock, symptoms will be presented due to the laceration which necessarily occurs because of the jelly-like consistence of the brain. This view is partially substantiated by the statement of some surgeons that, in all instances of concussion severe enough to cause unconsciousness, serious symptoms are liable to ensue. This theory would place under the head of shock those temporary symptoms now called slight concussion, and would class all other instances of brain injury of a similar character as contusion or laceration of the brain.

Lacerations and contusions of the brain may be multiple, giving rise to numerous minute extravasations of blood, scattered throughout the brain and scarcely distinguishable from the normal vascular points seen on section. On the other hand, hemorrhage from the torn vessels may be so great and so diffused as to produce symptoms of compression of the brain, thus greatly obscuring the diagnosis. The irregularity of the base of the skull causes laceration to occur most frequently in the corresponding region of the encephalon.

Causes.—Direct violence to the head, or force applied to the legs or buttocks and transmitted through the spinal column to the cranial bones,

are the causes of contusions and laceration of the brain. A blow on one part of the cranium will often give rise to laceration of the brain at the opposite side without there being any marked injury to the cerebral tissue immediately underlying the bone struck. This is due to the soft consistency of the brain, and is termed contusion by counter-stroke.

Symptoms.—When a slight blow has been received by the brain the patient at once becomes giddy, is confused in his ideas, feels weak, staggers and perhaps would fall if not steadied by grasping some neighboring support. At the same time his face becomes pallid, and his heart's action feeble. There is a feeling of nausea, and vomiting sometimes actually occurs. These slight cases do not exhibit actual unconsciousness, but the patient is "stunned," and for a moment is not able to collect his thoughts. He in a moment promptly returns to his normal state.

This is the condition in which it is possible, perhaps, that no laceration of nervous structure or bloodvessel occurs; and such cases are those that resemble surgical shock of slight severity.

The violent shaking of the brain caused by the application of a severe force is followed by symptoms of gravity, which are due, in my opinion, to the production of contusion or laceration of the brain or its membranes. The patient is almost, but, as a rule, not completely, unconscious; lies motionless with a cold, pallid skin, has a feeble, fluttering pulse and heart, and sometimes passes urine and feces involuntarily. The insensibility is not a complete coma, for usually the patient can be roused by loud questioning to utter a monosyllable or a groan. The pupils vary in different cases as to contraction or dilatation, and the two eyes may not be alike in this respect. Usually the pupils react to the stimulus of light. The breathing is quiet, though it may be feeble and shallow; there is no hemiplegia, and the limbs if pricked with a pin will be withdrawn, though probably in a lazy manner. Vomiting is liable to occur as the patient begins to react from the semi-unconscious condition which has immediately succeeded the injury. Convulsions sometimes take place after such cerebral injuries. The location of the contusion is an important factor in the determination of special symptoms. The symptoms just described may last a few hours or a day, before signs of recovery or of progressive inflammation supervene. When return to health is to ensue, the symptoms of brain contusion slowly subside and the patient's functions assume their normal condition. It often happens, however, that headache, vertigo, impaired memory, and other cerebral sequelæ remain. When the issue of the injury is to be an unfavarable one, the patient either sinks into a comatose state, without reacting, or, if he does react, soon presents the characteristic symptoms of encephalitis.

The prognosis is grave in all cases of contusion of the brain, because it is impossible to define accurately the extent of the lesion, and because even slight lacerations and contusions are liable to impair the mental functions and the special senses. All injuries producing vibration or concussion of the brain that are followed by the semi-unconsciousness mentioned are serious, because there is organic lesion of the brain tissue.

Some writers speak of three stages of concussion of the brain—namely: collapse, reaction, and inflammation.

I object to this division, and, indeed, ignore entirely the term concussion of the brain, since I do not believe in the existence of a functional disturbance of the brain without organic lesion. Concussion of a muscle or bone causes a definite lesion called contusion, laceration, fracture; so concussion of the brain, if it produces symptoms, must cause an organic

lesion. In cases subjected to careful autopsy such lesions are found, though it is possible that instances may occur in which organic change is too slight to be appreciated by our present knowledge and means of investigation.

Concussion or vibration of the brain should not be considered a condition of disease of the brain, but merely a cause of contusion and laceration of the organ. Let the term concussion, as usually employed, be dropped, and contusion or laceration substituted, and such symptoms as those I have been describing will be better understood and better treated. The three stages of concussion, called the stage of collapse, that of reaction, and that of inflammation, are relics of the old nomenclature, and are unnecessary. If concussion is synonymous with contusion or laceration, as it should be, the occurrence of reactionary and inflammatory phenomena is readily intelligible.

Treatment.—As the symptoms are those of shock, combined with those of brain contusion and laceration, the treatment is obviously clear. At first absolute quiet in the supine position, with the feet elevated slightly and the head low, should be enjoined. A darkened room and an opportunity to sleep should be afforded. Stimulants will rarely be needed, and should be avoided if possible; because, after the shock of injury has passed away, cerebral excitation and plethora will tend to produce hemorrhage from the torn vessels, and to set up inflammatory engorgement. Agents, such as ammonia, that stimulate momentarily, are preferable to the more lasting alcoholic preparations. External applications of heat or of mustard to the general surface may be available to relieve the depression. When the pulse shows increasing strength, or there is evidence in the reddening of the skin that reaction has commenced, the surgeon must adopt measures to prevent the occurrence of cerebral inflammation. The head should be elevated, cold applied locally, and bromide of potassium, purgatives, and other remedies employed in the manner described when speaking of inflammation of the brain from surgical causes. Even bloodletting may be required, though in the early hours after the injury such treatment might prove fatal. It requires the exercise of great judgment to manage such cases. The measures appropriate for the first few hours' treatment of contusion of the brain are diametrically opposed to the line of treatment required after reaction has been induced. It is a nice question to know when the change should be made.

All cases of contusion of the brain, however slight, require surgical supervision for a long time. Indiscretions in mental work, in diet, or in physical exercise may be very deleterious.

Compression of the Brain.

Definition.—Compression of the brain is said to exist when pathological lesions or changes exert such pressure upon the organ as to displace the cerebral substance or cause flattening. The symptoms are probably due, to a great extent at least, to the pressure impeding cerebral circulation and causing a local deficiency of blood supply. It is certainly not likely that the amount of force exerted by extravasated blood, which so often gives rise to compression symptoms, is sufficient actually to compress and condense the brain substance. It would require comparatively little pressure, however, to interfere with the calibre of the capillary blood-vessels.

Causes.—The causes ot compression of the brain are: 1. Extravasation of blood upon the surface or in the interior of the brain. 2. Fractures of the skull, accompanied by depression of the fragments. 3. Foreign bodies driven through the skull upon the surface of or into the brain. 4. Inflammatory deposits of serum, lymph, or pus. In the second and third instances bleeding, due to laceration accompanying the fracture or wound, has frequently much to do with the occurrence of compression. A comparatively sudden pressure seems to be requisite to produce compression symptoms. If blood, for example, be slowly extravasated, the brain seems to accommodate itself to its new relations, unless the amount of blood be great.

Symptoms.—A patient suffering with compression of the brain is dead to external impressions, but the organic functions of respiration and circulation continue. He lies on his back, totally unconscious and immovable, with pupils unaffected by light, and one or both of them usually moderately or considerably dilated. The respiration is slow (ten to sixteen per minute), snoring, and accompanied by a peculiar whiff or puffing out of the cheek at the corner of the mouth. The stertor is due to paralysis ot the palate muscles. It may be greatly diminished by turning the patient on his side, so that the relaxed soft palate will not hang unsupported in the current of air. The puffing out of the cheek is due to loss of power in the buccal muscles. The pulse is slow and rather full, beating perhaps not more than forty or fifty times in a minute. The urine is retained until the paralyzed bladder becomes so distended that there is a dribbling overflow. Constipation, followed by relaxation of the anal sphincter and consequent incontinence of feces, is often found. Hemiplegia of the side opposite the injury is usual. This cannot be determined in cases where reflex sensibility is destroyed, unless it is evident from the distortion of the face. The condition of the pupils and the extent and character of the paralysis depênd upon the situation of the compressing lesion. The group of symptoms given are those found in typical cases of compression, and are those of cerebral apoplexy, which is a form of compression.

Symptoms of compression due to depressed bone or to foreign bodies lodged in the brain arise immediately after the receipt of injury. Extravasation of blood, unless profuse, causes a gradual supervention of symptoms, while compression from inflammatory products appears only at a later period. It is probable that a factor in many cases of compression from depressed fracture is the concomitant occurience of inflammation, whose symptoms are blended with those due to the pressure which often is too slight to cause in itself serious symptoms.

If the pressure is not relieved by treatment, and the cerebral mass fails to accommodate itself to the new relation of parts, coma deepens, the organic functions become gradually involved and death occurs. The time occupied in the fatal invasion and destruction of these functions is usually a few days, though it may extend through weeks.

Diagnosis.—Typical cases of compression of the brain are readily distinguished from contusion or laceration (so-called concussion) of the brain of moderate severity. If a laceration or contusion is sufficient to cause much hemorrhage, however, compression symptoms will coexist and complicate the diagnosis. So, on the other hand, laceration and contusion of the brain substance is liable to result from the same force that produces a depressed fracture and a consequent depression. Hence, it is often impossible to determine accurately the pathological lesion.

The points upon which a differential diagnosis may be founded in uncomplicated cases are given in the following table:

Compression.	*Contusion or Laceration (Concussion).*
1. Symptoms may not be immediate after injury.	Symptoms always immediate.
2. Complete unconsciousness and total insensibility to impressions upon organs of sense.	Partial unconsciousness and only impaired sensibility to impressions upon organs of sense.
3. Respiration slow, stertorous, and puffing.	Respiration quiet.
4. Pulse slow and full.	Pulse frequent and feeble.
5. No vomiting.	Sometimes vomiting.
6. Retention of urine and often of feces.	Incontinence of urine and feces.
7. Paralysis, usually hemiplegia, of opposite side.	No paralysis.
8. Pupils insensible to light.	Pupils react somewhat to light.
9. Deglutition impossible.	Deglutition possible.

In the absence of a history of the patient before unconsciousness occurred, it is frequently difficult and sometimes impossible to discriminate between coma due to compression of the brain, alcoholic or narcotic poisoning, uræmia, apoplexy, sunstroke, and hysteria. An unconscious man with bruises upon the head, picked up in the streets, may be suffering from brain compression due to injuries received while intoxicated; or may have fallen from an elevation because of an apopletic seizure or sunstroke, and thus have sustained secondarily a depressed fracture of the skull. In such cases the head should be shaved, and careful examination made for signs of injury to the skull; the urine should be examined for albumin and tube casts, alcohol, opium, and other poisons; the temperature should be taken, and tests of electro-muscular sensibility and contractility should be instituted.

The ophthalmoscope will sometimes be of service in disclosing albuminuric retinitis and choked disk, or other changes in the fundus.

The existence of paralysis in compression of the brain usually serves to distinguish it from the conditions named, with the exception of apoplexy. It is the compression produced by the hemorrhage in an apoplectic seizure that induces many of the symptoms; hence, a diagnosis is impossible unless the history and evidences of injury afford direct information. The treatment, however, is identical in such conditions.

The odor of poisons, the contracted pupils of opium narcosis, the œdema of chronic Bright's disease, the high temperature of sunstroke, and the sex in hysteria will aid in the differentiation of some obscure cases. Such evidence is fallible, however, and it may be that the surgeon's opinion must be suspended until the progress of the case clears up the obscurity. The patient may indeed be suffering from two conditions at the same time.

Treatment.—Compression of the brain demands removal of the cause if this can be done without inflicting more serious brain injury. Depressed bone should be elevated; foreign bodies extracted; pus evacuated by trephining; extravasated blood removed and further bleeding prevented by opening the skull, turning out the clots, and tying the vessel. These operative procedures are proper only when the existence of compression is clearly established, and its cause and location known. Investigations of the localization of cerebral lesions and improved methods of treating

wounds have made such operations more frequently justifiable than was formerly the case. When such measures are not deemed wise, the patient should be treated on the general principles laid down for the prevention of encephalitis.

Purgatives, bromide of potassium, iodine and its compounds, mercury, and bloodletting are the remedies to be employed. If hemorrhage is supposed to be the cause of compression, the head should be elevated. Enemas may be given to empty the lower bowel. The catheter must be introduced twice or thrice daily to withdraw the urine from the paralyzed bladder.

Tumors of the Brain.

Tumors of the brain may be fibromas, sarcomas, carcinomas, cystic tumors, etc. They may have their seat between the dura and the cerebral convolutions, or they may be more or less deeply imbedded within the brain tissue. The symptoms depend upon the position of the growth and its size. Epileptic convulsions, local paralyses and spasms, choked disks, aphasia, and intellectual aberrations all occur. It is the simultaneous or consecutive occurrence of these and other symptoms which enables the neurologist to localize the position of the growth. If such a tumor does not involve the basal ganglia, nor occupy a position so far under the base of the brain as to make access impossible, it is proper to attempt its removal by opening the skull and excising it. Such operations should be done with the strictest antiseptic precautions and by means of a large trephine and gnawing forceps. Provision must be made for drainage, even if the opened dura mater is subsequently sutured, as it usually should be, and if the button of bone cut out by the trephine is replaced before the scalp flap is sutured into position. The details of such operations will be found in the various monographs which have recently been written on this subject.

Growths situated at some distance below the surface of the convolutions are not accessible until the surgeon has incised the brain tissue. This procedure is justifiable, if punctures carefully made with a probe or grooved director give evidence of a tumor below the surface. When the clinical history of the patient shows evidence of multiple brain tumors or of a tumor which is evidently a secondary malignant growth, it is scarcely proper to attempt removal. The diagnosis in cases of suspected brain tumor is very difficult and requires the most careful consideration of the skilled neurologist. It is probably true that surgeons usually have not the special knowledge which enables them to make an absolute diagnosis as to location. Hence, examination of the eye grounds, of the paralytic symptoms, and of the epileptiform seizures should be made by those who are trained to such matters. When a reasonable diagnosis has been made by such expert observation, it is proper to perform an exploratory operation.

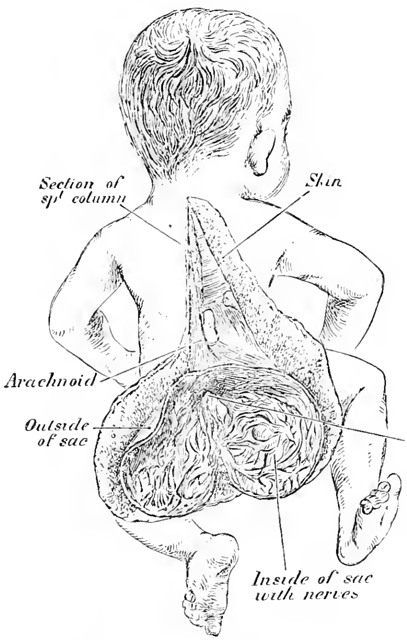
Diseases and Injuries of the Spinal Cord.

Hydrorachis or Bifid Spine.

Hydrorachis is a congenital protrusion of the membranes of the spinal cord and sometimes of a portion of the cord itself or of the spinal nerves through an opening in the posterior part of the vertebral column. The

deficiency of the bony wall is due to imperfect development of the laminæ and spinous process of one or more vertebræ; hence, the name of bifid spine. The protruded membranes are distended by cerebral spinal fluid forming an elastic and sometimes fluctuating tumor. A more proper name would be spinal meningocele. Those protrusions containing portions of the cord would then be called myeloceles. The deformity occurs most frequently in the lumbo-sacral region.

FIG. 80.



Dissection of hydrorachis. (BRYANT.)

The tumor varies in size and in tenseness with the position of the child, and in occasional instances has no cutaneous investment whatever, being a mere sac of thin spinal membranes. It is apt to become more tense or larger when the child cries. The fluid can sometimes be pressed back into the spinal canal so that the edges of the fissure in the bones can be distinctly felt. Hydrocephalus and other deformities are often found in the same infant. Paralysis is not uncommon. Death generally occurs from meningitis, convulsions, or paralysis, or from rupture or ulceration of the sac.

Support and moderate pressure by means of elastic bandages or cup-shaped pads afford proper palliative treatment. When the growth is rapidly increasing a portion of the fluid may be withdrawn by an aspiration-needle, introduced at the side of the median line where nerves are not likely to be situated. If the orifice of communication with the spinal canal is small, injections of tincture of iodine, ligation with the elastic ligature, or excision may be practised. All tumors over the spine in children are not cases of bifid spine; but the possibility of this condition

existing should always be in the surgeon's mind before undertaking operation.

Inflammation of the Spinal Cord from Surgical Causes.

Varieties.—The inflammatory process may be located in the membranes (spinal meningitis), or in the substance of the cord (myelitis). It frequently happens that meningitis and myelitis are associated.

Pathology.—In traumatic cases the inflammation is usually local, but the pathological changes may gradually spread along the spinal marrow. Injection of vessels, effusion of serum, exudation of lymph, formation of pus, and softening of nervous structure are the results found at the after-death examination. Sclerosis may occur in chronic cases.

Causes.—Intraspinal inflammations of surgical causation arise from contusions or lacerations, and other direct wounds of the contents of the vertebral canal; and from fracture, caries, and necrosis of the vertebræ.

Symptoms.—There are certain differences in the symptomatology of meningitis and myelitis which will be discussed in speaking of diagnosis. Here the symptoms of spinal inflammation in general will be described.

As the cause is local the inflammation is limited; hence, chills, high fever, and great constitutional disturbance are unusual. Pain in the spinal region, aggravated by motion or pressure, and often reflected along the nerve trunks, is exhibited. Burning and tingling sensations and a feeling of insects creeping over the body; local hyperæsthesia of the surface; more frequently cutaneous anæsthesia; delay in perceiving the contact of points; and a sense of constriction about the body marking the upper limit of the disease are common symptoms of inflammation of the cord and its coverings.

Muscular jerkings and spasms, and subsequently permanent muscular contractions, affecting the muscles supplied from the diseased region, are especially associated with meningitis. Motor paralysis below the seat of lesion is usually present, being much more permanent and complete in myelitis.

The palsy, as a rule, involves both sides, and is due to division, compression, or disorganization of the nerve fibres of the cord. If paraplegia occurs immediately after the receipt of injury, it indicates that the fibres are divided, or have been compressed by displaced bone or extravasated blood. A slowly determined paralysis suggests inflammatory pressure or disorganization. Injury of one side of the spinal marrow would give rise to unilateral palsy on the same side. It is possible in lesions of the cervico-dorsal area of the cord to have motor paralysis of the arms and not of the legs. As the cord terminates at the level of the second lumbar vertebra, injuries below this point are accompanied by no paralysis, or by a slight and temporary form only which depends upon lesions of the loose bundle of nerves called the horsetail. The small diameter of the cord immediately above its lower end and the envelopment of this termination in the nerve roots going down the vertebral canal serve to prevent severe involvement of the cord, even at a somewhat higher level than the lumbar vertebra mentioned.

The seat of the cord lesion can often be determined by the limitation of the motor or sensory paralysis. The muscles and regions supplied by branches given off from the spinal marrow below the injury are usually the only ones that lose their innervation. On account of the downward distribution of the nerves as they leave the cord, the lesion is generally

somewhat higher than the horizontal line marking the upper limit of the palsy. An exception to this may occur when the terminal nerve filaments are distributed upward. This occurs especially in the skin.[1]

The paralyzed parts are exceedingly liable to severe bedsores. These are due to the impaired innervation and circulation and to the unrecognized irritations which the insensible and immovable parts receive. The local temperature of the palsied limbs is often high. Atrophy soon occurs. Bedsores and atrophic changes are more marked the longer the patient survives. Hence, in injuries low down in the cord these nutritional changes are exceedingly conspicuous.

Retention of urine occurs nearly always. When the paralyzed bladder has become fully distended, there is a dribbling overflow, which is an indication for an immediate catheterization, lest rupture of the bladder or other harm result. After a few days' incontinence of urine relaxation of the sphincter supervenes. The bladder is thus kept nearly empty. At the same time the urine exhibits chemical changes, becoming alkaline, turbid, ammoniacal and filled with mucus and phosphates. Inflammation of the bladder is usually found at this period, due either to the distention and catheterization, or the alkaline urine, or perhaps to both. Other changes, such as the presence of sugar, are occasionally witnessed.

Priapism, either spontaneously exhibited or following catheterization and handling of the genitals, occurs in many instances where motor palsy is a symptom. It has no connection with sexual feelings, and only exists when loss of motion is present.

Incontinence of feces is seen when the sphincter is paralyzed by injury to the lowest region of the cord. If the damage is effected higher up, constipation is the condition exhibited. This may subsequently be followed by looseness of the bowels.

Dyspnoea and hurried respiration result when the spinal inflammation is located in the upper dorsal and cervical regions because of paralysis of the intercostal and serrated muscles. If the injury disorganizes the cord above the origin of the phrenic nerve, or if inflammatory destruction ascends thus far (to the third or fourth cervical vertebra), death occurs instantly from paralysis of the diaphragm. Difficulty of respiration is experienced in intraspinal troubles in the lower dorsal region; first, because there is paralysis of the abdominal muscles which aid expiration, and also because the loss of muscular tonicity here allows tympanitic distention of the intestines to occur and interfere with the descent of the diaphragm.

When the sympathetic cardiac nerves are interfered with by lesions in the cervico-dorsal region, the pneumogastric nerve can then exert its inhibitory function unrestrained, and the heart's action is slowed. Otherwise the pulse is influenced merely by the general state of the patient.

There are many other symptoms of intraspinal inflammation which depend upon the location of the lesion and the nervous centre consequently involved. From these the location of spinal lesions is established with considerable certainty. It must be remembered, however, that in some cases brain injury has been associated with the spinal hurt. It is occasionally difficult to differentiate the spinal from the cerebral symptoms.

[1] See Spinal Localization in its Practical Relations. Therapeutic Gazette, May and June, 1889, by Dr. Charles K. Mills.

Unconsciousness, when present, renders the diagnosis of cerebral involvement clear.

Diagnosis.—Meningitis and myelitis are often combined, but the predominant affection can, at times, be diagnosticated by the character of the symptoms. In meningitis there is more pain on motion, more cutaneous hyperæsthesia, more twitching and permanent contraction of muscles, less impairment of motility, less involvement of the bladder and rectum. Effusion occurring in meningitis may cause paraplegia by pressure on the cord, but the paralysis is not as complete as in myelitis, and varies in its degree. In myelitis the loss of power occurs earlier and is more marked, electric contractility and reflex movements are soon impaired, and the sense of constriction about the trunk is conspicuous. Priapism, urinary complications, bedsores, and nutritive changes are usual.

Prognosis.—The higher the seat of inflammation the graver the prognosis as to prolongation of life, because more of the vital functions are impaired. Myelitis is a much more serious affection than meningitis, and is seldom followed by restoration of the paralyzed limbs. If the injury is low down in the spine, or if, when higher, it implicates a limited area of the cord, recovery of a fair amount of health occasionally takes place. Contractures and paralysis, however, usually remain. Sensation is usually regained sooner than motion.

Treatment.—Intraspinal inflammation requires a line of treatment similar to that recommended in encephalitis. Rest, preferably in the prone position, the ice-bag, leeches or wet cups locally; hydragogues, iodide of potassium (gr. x to ʒj), or mercury to slight ptyalism, and fluid extract of ergot (fʒss to fʒj), given internally several times daily, are the proper measures in acute cases. Morphia and bromide of potassium may be employed to relieve pain and induce functional rest. Atropia is an appropriate remedy in meningeal congestion. When the condition is subacute, blisters or the actual cautery may be applied to the spine and the induced current to the paralytic muscles with advantage. Hammond says that in acute partial myelitis he has got benefit from large doses of ergot, and the actual cautery applied along the sides of the spinous processes. Strychnia is to be avoided in spinal meningitis. The paralyzed muscles of chronic myelitis should be treated by means of electricity, massage, the hot and cold douche, and subcutaneous injections of strychnia, in the endeavor to prevent atrophy and restore power. Syphilitic meningitis and myelitis especially call for mercury and iodide of potassium in active doses.

Suspension by the shoulders and head from a tripod, so as to extend the spinal column by the weight of the lower limbs, has been advocated in some forms of chronic disease of the cord.

When retention of urine exists, the catheter must be passed three times daily. The cystitis that arises later and is accompanied by phosphatic urine, is alleviated at times by carefully washing out the bladder with nitric acid and water (♏v to fʒj). Even if incontinence has occurred, it is well to pass the catheter once every three or four days to empty any decomposing residual urine.

An attempt at preventing bedsores should be made by seeing that there are no folds in the sheets, by bathing the prominent points of back and limbs with alcohol, and by keeping them free from contact with the urine and feces. It is well to place the patient as soon as possible upon an air or water bed. A good water bed can be improvised by partly filling a long tank or tub with water, and nailing a rubber blanket over the top, so that it will rest upon the surface of the water.

If a clear diagnosis of abscess within the spinal canal was made, it would be justifiable to trephine the vertebra, or to saw away the laminæ in an effort to evacuate the pus. In localized inflammation due to fracture or other cause, trephining followed by separation of the adherent membranes and cord might possibly give relief to the symptoms. Exploratory operations here, as in brain diseases, are justifiable.[1]

Wounds of the Spinal Cord.

Wounds of the spinal marrow may be produced by gunshot injuries, by fractures of the spinal column with displacement, or by pointed instruments thrust between the vertebræ. The symptoms will be those previously detailed as occurring in injuries and inflammation of the cord. They will vary with the locality of the wound. Such wounds, involving a limited portion of the diameter of the cord will be followed by a limited paralysis, corresponding with the fibres divided.

The treatment of wounds of the cord is such as is detailed for arresting and treating intraspinal inflammation. When fragments of the vertebra are driven in upon the cord instrumental elevation is justifiable, but the diagnosis of such compression is often difficult. Exploratory operation may then be demanded.

Concussion or Contusion, and Laceration of the Cord.

Shocks, whether direct or indirect, to the spinal column are not transmitted to the cord as readily as similar blows are to the brain, because the cord hangs loosely in the canal, and is surrounded by the spinal fluid. I believe that cases denominated concussion of the spine are really instances of contusion or laceration of the cord or its membranes or of extravasation from rupture of the spinal veins. The progressive spinal symptoms described by Erichsen as occurring after the jarring of railway accidents, and attributed by him to so-called spinal concussion, are, in my opinion, probably due to slight contusion or laceration of the contents of the spinal canal.

Contusion and similar injuries of the cord require treatment adapted to preventing and allaying inflammation of this nervous centre.

Neuritis, or Inflammation of Nerves.

Causes.—Neuritis, which may be acute or chronic, arises from exposure to cold and wet, wounds, strains causing laceration of the nerves, rheumatism, gout, and syphilis. Acute neuritis is particularly liable to follow laceration of nerve-trunks; and yet nerves may often be exposed to considerable traumatic irritation without becoming inflamed.

Pathology.—An inflamed nerve shows changes in the neurilemma and nerve-fibres. Hyperæmia, increased connective tissue, serum, lymph, and pus are the inflammatory changes associated with the former; while granular and fatty changes followed by softening and atrophy occur in the latter. In acute neuritis the nerve-trunk is swollen from the deposition of inflammatory fluids, and pus may be found within the sheath.

[1] See Surgery of the Spinal Cord, by Dr. J. William White. Annals of Surgery, July, 1889.

If the nerve is superficial a hardened cord is often felt beneath the skin. In chronic inflammation an increase of the connective tissue, leading to sclerosis and consequent nerve atrophy, is the usual pathological change.

Symptoms.—Inflammation of nerves causes disturbance of physiological function, hence the symptoms vary as the nerve-trunk is motor, sensory, or mixed. Inflammation of nerves of special sense, such as the optic and auditory, is not discussed here, but belongs to the domains of ophthalmology and otology.

The first effect of inflammation is to increase the irritability of nerves, but, as it continues, a diminution of nervous excitability is induced. Hence, in motor neuritis, twitching and spasm of the muscles occur at the time of invasion, and are followed by paresis or complete loss of power if the inflammation is not speedily arrested. Sensory neuritis exhibits mainly pain and hyperæsthesia followed by analgesia and anæsthesia. When the inflammatory process resides in a mixed nerve, as it generally does in cases met by surgeons, these classes of symptoms are combined. Reflex influences may at times, however, cause the appearance of symptoms of a motor character, even when a purely sensory nerve is inflamed. For example, neuritis of the trifacial will be accompanied by twitching of some of the muscles of the face. The term causalgia is applied to the peculiar burning pain of some nerve inflammations.

Inflammation as found in neuritis of the sciatic, radial, and similar nerves, then, is exhibited by pain, of a remittent, but not intermittent, character, increased by pressure, often worse at night, and especially severe when due to traumatism. There will perhaps be reflex symptoms such as pain in other parts of the body. The painful sensations are felt in the peripheral distribution of the nerve, and may exist even when the skin has become anæsthetic. Reflex excitability and electric contractility are soon diminished. The local temperature of the parts supplied is increased, and the skin over the course of the trunk is red, and sometimes the seat of a bullous eruption. A hard, painful, cord-like swelling is felt along the course of the trunk, if it is a superficiul nerve that is involved. Clonic spasms, loss of power, hyperæsthesia, anæsthesia, and atrophic changes are supplementary symptoms.

Fever and other constitutional symptoms occur, varying in intensity with the acuteness of the neuritis.

Chronic neuritis causes much less pain, but the other functional disturbances are those already mentioned.

Neuritis may spread along the trunk to nerves nearer the nervous centres. This is called ascending neuritis. In a similar way changes may occur above and spread downward, constituting descending neuritis. Neuritis may be followed by ulceration, deformity of joints, and other secondary pathological conditions.

Diagnosis.—Neuritis is distinguished from neuralgia by the continuous pain, which may remit but does not intermit; and by the fact that the pain is usually less severe than the paroxysmal pain of neuralgia. In neuralgia, moreover, there is not the local elevation of temperature, the muscular spasm, the paralysis of motion or sensation that have been mentioned as symptomatic of neuritis.

Treatment.—Acute neuritis demands absolute rest and elevation of the part, ice-bags locally, and, perhaps, local abstraction of blood. Deep subcutaneous injections of morphia (grain $\frac{1}{8}$ to $\frac{1}{4}$) with atropia (grain $\frac{1}{60}$) over the painful nerve, and the application of the primary galvanic

current has been useful. The general disturbance will probably necessitate at the same time the use of diaphoretics and laxatives.

Chronic inflammation of nerves is to be treated by blisters, electricity, the actual cautery and increasing doses of iodide of potassium. Hypodermic injections of chloroform, solutions of osmic acid or of cocaine may at times be serviceable. Nerve-stretching is a recently introduced operation for chronic pain of nerve-trunks. The nerve is exposed by an incision and stretched by being forcibly pulled out of its bed by the surgeon's finger or a hook.

If the inflammation is due to rheumatism, alkalies and salicylate of sodium are indicated; if to gout, colchicum; if to syphilitic causes, mercury and iodide of potassium.

The actual cautery has been used also in acute neuritis with alleged benefit.

The atrophied muscles are to be subjected to massage, electricity, douches, and hypodermic injections of strychnia (grain $\frac{1}{50}$).

Tonics and similar remedies will often be of value in chronic neuritis.

Injuries of Nerves.

Nerves are liable to be bruised and lacerated as occurs when the ulnar is compressed against the internal condyle, and when the circumflex is torn in dislocation of the head of the humerus.

They may be punctured, incised, completely divided, or have a portion excised.

Symptoms.—The symptoms in such injuries, whether open or subcutaneous, vary with the degree of damage done to the nerve-fibrils. Slight contusions cause pain at the point of injury and tingling or numbness along the peripheral branches. Other wounds give rise to pain followed by paresis or paralysis. Sometimes pain is absent. A foreign body impacted in a nerve is apt to cause spasmodic action of the muscles in addition to the pain and other symptoms.

Subsequent to the receipt of injury the symptoms of neuritis occur. Neuralgia is often developed as a sequel to nerve wound. This is especially the case in hysterical subjects. When the nerve is compressed or dragged upon by the cicatrix of the wound in the other tissues, nutritive changes take place in the parts deprived of innervation. These consist in atrophy and contracture of muscles; alterations in the nails; and changes in the skin, which may become shining and swollen or eczematous; lowered local temperature; loss of hair; and subacute arthritis.

The ends of a divided nerve retract, become bulbous from the deposition of lymph, and, after the lapse of several weeks or months, are re-united by the development of nerve tissue, thus having their function restored. This will at times happen even when a considerable piece of nerve has been cut out. Hence, when it is desirable, after operation for neuralgia that union should not occur it is necessary to excise a long piece of nerve trunk or turn back the distal end. During the period required for restoration of function the neighboring nerves seem at times to fulfil, in part at least, the duties of the injured trunk in much the same manner as the collateral circulation is carried on when an artery is obstructed.

Treatment.—Subcutaneous nerve injuries need only such treatment as will prevent or allay the resulting neuritis. Hypodermic injections of morphia and atropia, cold, or perhaps hot applications, and galvanism

locally, with quinine or other appropriate remedies internally, are judicious measures. Other local remedies of value are belladonna extract, menthol, chloroform and aconitia, used as lotions or ointment, blisters, leeches, and the actual cautery. In open wounds, where there is a tendency to considerable separation, union can very properly be hastened by suturing the extremities together with catgut. No special manner of introducing such stitches is required, if only approximation is accurately made.

The after-treatment is that calculated to prevent neuritis. If a wound, in which there was a large nerve divided has healed and permanent paralysis remains, it may be justifiable to expose the nerve, cut off the bulbous or atrophied extremities, and apply sutures. Considerable success has been obtained in restoring motion to limbs, the subject of traumatic paralysis from accidental nerve section. Pieces of nerve tissue from the rabbit may be sutured in the gaps left by destruction or excision of nerve trunks.

Neuralgia, due to cicatricial pressure, is treated by excising the innodular tissue, and thus getting rid of the scar and the pinched nerve. Other neuralgias after nerve injuries require the treatment detailed in the article on Neuralgia.

Neuralgia.

Definition.—The term neuralgia was introduced into medical language to signify pain referred to the course of a nerve without apparent lesion. The pain was said to be functional. Pathological observation, however, has shown that many instances of pain, formerly called neuralgia, are really due to inflammation or compression of the nerves, or to other definite organic changes. Neuralgia should, therefore, be restricted to nerve pain in which no lesion is evident, though more accurate pathological knowledge will doubtless still further lessen the cases to which the name is appropriate.

Neuralgia then may be defined as pain, usually paroxysmal, situated not in the brain or cord but in the nerves themselves, and due to no discoverable organic lesion.

Causes.—The chief constitutional cause of neuralgia is debility. When the powers of life wane from old age, or when anæmia exists in young or old, there neuralgia is liable to appear as an unwelcome visitor. Malaria is a very frequent cause of neuralgia, especially of the trifacial nerve. Hysteria, exposure to wet and cold, reflex irritation from uterine disease, syphilis, rheumatism, and gout are considered factors in the etiology of neuralgia. Some of these probably cause nerve pain by inducing neuritis and not true neuralgia. The same fallacy is likely to underlie cases of neuralgia attributed to diseased teeth, necrosis of bone, and periostitis. Compression of nerves by tumors and periostial thickening gives rise to neuralgic pain.

Symptoms.—The most frequent situations for neuralgia are the terminal branches of the three divisions of the trifacial nerve, the sciatic nerve, and the intercostal nerves. Neuralgia may be seated in a number of small, nervous twigs, distributed to an organ or surface of considerable size; thus, we have neuralgia of the breast, of the testicle, and of joints.

The pain of typical neuralgia is sudden and paroxysmal. It occurs as a tearing, darting shock or pang followed by an interval of more or less complete absence of pain. In many instances there is a dull, aching pain

continuously, to which are added at irregular intervals the painful exacerbations. Muscular exertion generally, and pressure sometimes, though not usually, aggravate the pain. Neuralgia shows quite a tendency to be unilateral, and often there is exhibited marked cutaneous hyperæsthesia.

Points of tenderness on pressure can, as a rule, be found along the course of the nerve. These are situated where the nerve passes through a bony foramen, pierces the deep fascia, or comes near the surface of the body. Occasionally tenderness is exhibited over the part of the spinal cord from which the nerve takes its origin.

Local muscular spasm is found associated with some neuralgias, as are at times a hot, red, swollen skin and increased secretion of the neighboring lachrymal or salivary glands. The peculiar vesicular eruption called herpes zoster is developed over the line of a neuralgic nerve.

Patients who have once suffered with neuralgia are liable to similar experience at every exposure to the exciting cause.

The location of the neuralgia may vary with each attack. Indeed, the pain is very liable to change from one nerve to another.

Neuralgia, particularly of the trifacial nerve, is often very intractable, but it is not a disease dangerous to life.

Diagnosis.—It is easy to differentiate a typical neuralgia from marked organic disease. There are no alterations in shape or volume, no signs of inflammation, no fever, but paroxysmal pain, cutaneous hyperæsthesia, and a history of debility, malaria, or hysteria. Firm pressure frequently relieves neuralgic pain, if it is continued until the hyperæsthetic skin has become accustomed to the contact of the hand. The tendency of neuralgia to be transferred from one nerve to another is a valuable point in diagnosis. In many cases, however, neuralgia can only be presumed to exist, because the pain cannot be attributed to any other affection. Muscular and fascial pains due to rheumatism or syphilis are often mistaken for neuralgia.

Treatment.—As the constitutional condition underlying neuralgia is usually either debility or malaria, quinine and its congeners are the most useful internal remedies that we have. Quinine should be given in full doses even when no malarial history can be obtained. Twenty to thirty grains in the twenty-four hours may be curative when less doses have accomplished nothing. If this drug fails, recourse should be had to arsenic. The solution of arsenite of potassium should be given in doses of five to ten minims three times daily after eating, and be gradually increased. The same preparation may be employed hypodermically in about half this amount, diluted with water and also increased by degrees. Iron, strychnia, and cod-liver oil in large doses frequently repeated, galvanism, good nutritious diet, fresh air, sea bathing, change of scene and climate are valuable agents in combating the tendency to neuralgia. In hysterical subjects, valerian, bromide of potassium, and assafœtida may be available; in rheumatic cases, alkalies; in those of gouty diathesis, colchicum; and in syphilitics, iodide of potassium or mercury. Ergot and phosphorus have been recommended by high authority.

Uterine or other affections giving rise to neuralgia by reflex influence should be remedied by appropriate measures.

To relieve an attack of neuralgia, when present, morphia, atropia, chloral, hyoscyamus, bromide of potassium, alcohol and the inhalation of anæsthetics have a positive value. The use of such remedies is to be deprecated and their repetition avoided as far as practicable, because of the early necessity of increasing the dose and the liability of inducing in-

temperance in their employment. Neuralgic patients, for this reason, should not be informed of the name of the remedy administered. Aconitia may be given in doses of gr. $\frac{1}{200}$ and gradually and very cautiously increased. The benumbing effect of this powerful drug on the peripheral nerve is well known. Menthol locally gives at times relief.

The local treatment of neuralgia deserves attention. Any suspected local cause, such as diseased teeth or cicatricial pressure, should be removed. In many of these instances, however, the pain is probably due to a neuritis and, hence, is not true neuralgia. Hypodermic injection of morphia (gr. $\frac{1}{6}$–gr. $\frac{1}{4}$) into the nerve trunk or in its immediate neighborhood is a potent remedy and may not only palliate, but by repetition even cure. The needle of the syringe should be thrust deeply into the tissues and, if possible, into the nerve. Atropia (gr. $\frac{1}{60}$–gr. $\frac{1}{40}$) alone or combined with morphia, ether (♏ x–xxx), chloroform, or bromide of ethyl, or solution of osmic acid may be employed in a similar manner. These and other sedatives may also be used in the form of liniments and ointments. Aconitia (gr. v to ℥j of ointment), veratria (gr. xx to ℥j of ointment), and menthol are often very efficacious local applications. Heat and cold vary in different cases as to the amount of relief they afford. The primary galvanic current is at times useful. Blisters, strong water of ammonia, the actual cautery, and similar counter-irritants have a positive value in some instances. Acupuncture and galvano-puncture have been recommended.

Nerve-stretching, nerve-section (neurotomy), and nerve-excision (neurectomy) are proper surgical expedients only when the neuralgia is very severe and intractable.

Nerve-stretching is performed by making an incision over the trunk, isolating it and lifting it out of its bed by a hook or the fingers. Strong traction is then made upon it in the direction of the peripheral branches, that is, away from the cerebro-spinal end, a considerable increase in the length of the loop is apparent. If the operation is done without ether, or if only local anæsthesia has been employed, the traction is to be continued until numbness of the periphery is experienced by the patient. The operation is only painful on account of the cutaneous or muscular incisions. The numbness and paresis of the parts to which the nerve is distributed soon pass away. Nerve-stretching has accomplished many cures of neuralgia. It has also been done for spasm of muscles. Strong compression of a nerve against a bone or by a screw clamp may relieve neuralgia by crushing the nerve fibrils.

Simple section of a nerve is of little value in obstinate neuralgia, because union soon takes place; hence, excision of one or two inches is much more successful. The neurectomy or excision should remove a portion of nerve as far as possible behind the seat of pain, for this gives the best chance of getting above the seat of pathological changes. The distal end of the divided nerve may be turned back, or a portion of muscle may be interposed between the ends to prevent union and recurrence of pain. If the neuralgia depends upon peripheral nerve change, these operations are usually permanently beneficial; but if the pain arises from alterations in the nerve centres, nerve-stretching and neurectomy give only temporary comfort. The absence of pain for several months, however, is often a great boon. The palsy after neurectomy is generally permanent. It has been suggested to cut out the cortical brain centre, from which the painful nerve has its origin, if this can be determined by central localization.

The three divisions of the trifacial are often excised. The supraorbital nerve is reached by an incision along the supraorbital arch, after which the nerve should be cut off as far back in the orbit as possible. If the nerve comes through a distinct foramen, this foramen may be converted into a groove by cutting out the edge of the bone with a chisel and then a hook can be passed above the globe of the eye so as to enable the surgeon to drag the nerve forward. The infraorbital may be reached in a similar manner; by trephining both the anterior and posterior wall of the antrum this nerve may be cut off close to the exit of the main trunk from the round foramen in the sphenoid bone. It can be torn off nearly this far back by swiftly cutting away with a chisel the edge of the orbit and seizing it with strong forceps in the floor of the orbit. The inferior dental is best reached by trephining the ramus of the lower jaw and exposing the nerve in its canal. Another method is to lay bare the mental foramen, and by means of the disk of the surgical engine, or with chisels, to remove the roof of the inferior dental canal as far back as is deemed necessary. It must be recollected that the alveolar process in old persons, in whom these operations are especially demanded, is generally absorbed, and the canal is relatively further from the lower border of the bone than in young adults.

Tetanus.

Definition.—Tetanus is a disease characterized by persistent and painful muscular contraction due to abnormal excitability of the medulla oblongata and spinal cord, which is probably dependent upon inflammation of the central gray matter of these organs.

Pathology.—The weight of evidence was until recently in favor of considering tetanus a disease of the nervous system, and not a blood affection, due to the introduction of some poisonous agent into the circulation. The pathological condition was thought to be probably inflammation of the gray matter of the medulla oblongata and spinal cord. Hyperæmia, extravasation, exudations, and softening have been detected, especially in the posterior horns of gray matter and in their immediate vicinity. When the disease is caused by injuries to the lower extremities these changes are said to be found in the lumbar enlargement; when the wound is situated upon an upper extremity, in the cervical enlargement of the cord. Sometimes the nerves in the neighborhood of the wound are found inflamed, but this peripheral neuritis does not seem to be an essential lesion. The most recent investigations seem to indicate the probability that tetanus is due to a microörganism, which would explain its occasional contagiousness and many points in its clinical history.

Causes.—Traumatism is the usual exciting cause of tetanus, but it may, especially in hot climates, occur idiopathically. The latter is sometimes termed rheumatic tetanus. Occasionally tetanus seems to be endemic.

A sudden change from a high to a low temperature, with dampness, is liable, especially in military practice, to be followed by cases of traumatic tetanus. Traumatic tetanus often occurs in vigorous patients who have sustained injuries, but it is probably more frequent in those of lowered nervous tone from shock, hemorrhage, deprivation of food, and want of fresh air. It is said to be more common in the negro than in the white race. There is no direct relation between the severity of the injury and the tetanic symptoms. The slightest bruise, puncture or surgical opera-

tion may be followed by the most violent form of tetanus. Burns and lacerations are more apt to give rise to this complication than incised wounds. It is doubtful whether wounds of the feet and hands are especially prone to cause tetanus, though some authorities believe that such is the case. Tetanus in newly-born infants has been ascribed to the ligation of the umbilical cord, and to pressure upon the cranial bones during birth.

SYMPTOMS.—The symptoms of idiopathic tetanus are identical with, though usually less severe than, those of the traumatic form. The treatment is the same in both varieties, except that in one attention to the wound is required.

The time of appearance of traumatic tetanus is usually from five to ten days after the receipt of the injury; though the initiatory symptoms may be exhibited in a few hours, or delayed until several weeks have elapsed. The early cases are apt to be more acute in their progress, violent in symptoms, and fatal in prognosis. Digestive disorders, or general and indefinite uneasiness may perhaps be observed, or possibly the wound may become dry and unhealthy before the characteristics of tetanus are developed. In many instances, however, nothing unusual attracts attention until stiffness and pain in the muscles of mastication or pain in the epigastrium, proclaim the advent of this serious complication. It is rarely that the muscular spasm shows itself primarily in the wounded limb. Pain in the epigastrium from spasm of the diaphragm, or painful rigidity of the muscles that close the mouth and of the back of the neck, is the usual initiatory symptom. The muscles thus primarily affected are those supplied by the motor branch of the trifacial nerve, the facial, and the spinal accessory nerves. The muscular spasm is continuous, or tonic, though there are occasional paroxysms of increased contraction. The contraction is exceedingly powerful. The voluntary muscles, except those of the hands, feet, eyeball, and tongue, generally become rigid soon after the incipiency of the disease. The epigastric pain is attributed to spasm of the diaphragm, and it is believed by some that death may occur from cardiac spasm. These are possible examples of the tetanic spasm occurring in muscles of involuntary innervation. The pain accompanying the muscular spasm is severe, resembles that of ordinary cramps, and shows exacerbations at the times when the rigidity increases. When the posterior muscles are more especially affected the patient's head and legs are bent backward, until he assumes such an arched position that, if placed in the supine posture, only his occiput and heels would touch the bed. This condition is called opisthotonos. The term emprosthotonos is employed to designate a similar flexion forward, and pleurothotonus to denote lateral deflection. Opisthotonos more or less marked is the common posture; the others are very rare. The inability to open the mouth gives tetanus the popular name of locked-jaw. The medical term for the spasm of the jaw muscles is trismus. The power of tetanic spasm must be seen to be appreciated. Muscles may, at times, be ruptured by the violent contraction, and the patient becomes unconscious from the unendurable pain.

The patient suffers from difficulty in swallowing, dyspnœa, and sleeplessness. There is sometimes aphonia, and occasionally the tongue is bitten by a sudden paroxysmal spasm of the temporal muscle. On account of this danger the surgeon should avoid requesting the protrusion of the tongue. Viscid saliva may collect in the mouth and annoy the patient. The mind is perfectly clear, but the facial expression is charac-

teristic. The sardonic grin of tetanus, as it is called, consists in retraction and elevation of the corners of the mouth, closed teeth, transverse furrowing of the forehead, dilatation of the nostrils, and a fixed, anxious expression of the eyes. Constipation and retention of urine are usually present. Reflex excitability is so great that the noise of a suddenly closed door, a draft of air, the touch of the surgeon's hand, or a flash of light may induce an exacerbation of spasm. Respiration is embarrassed and quickened, and the pulse feeble. In the early stage there is little fever, but toward the termination of the disease high temperature and profuse sweating are not infrequent. Instances of very high temperature have been observed, and cases have been reported in which the bodily heat rose even after death.

The exhaustion arising from the continuous muscular action is very great, and is often the cause of death, before which relaxation may take place. The fatal issue may occur from spasm of the respiratory muscles, and possibly from spasm of the heart. Fatal cases terminate usually in from three to five days.

Diagnosis.—Local rigidity of the masticatory muscles, due to cold, or diseased teeth, is distinguished from tetanus by the absence of pain, the non-occurrence of paroxysmal increase of spasm, the absence of hardness of the abdominal muscles and of other tetanic symptoms, and, finally, by its curability, particularly after removing the cause. Spinal meningitis has a different history, gives rise to rigidity of the extremities and neck, rather than to trismus, and is followed by paralysis.

In hydrophobia we see a convulsed and restless face instead of the knit brow and grinning mouth of tetanus. Moreover, there is delirium, and the spasms are intermittent or clonic. The profuse secretion of saliva and the convulsive attacks following attempts at deglutition are not a part of the clinical history of tetanus.

Hysteria assumes the characteristics of tetanus. It may be differentiated by considering the sex and character of the patient, and by observing the absence of pain, the intermission or irregularity of the tonic rigidity, and the transient nature of the spasm when the application of the actual cautery is suggested.

Strychnia poisoning, particularly when produced by the repeated administration of small toxic doses, greatly resembles tetanus. Here, however, spasm occurs in the limbs sooner than in the jaw, epigastric pain is absent, and opisthotonos arises at an earlier time than in tetanus. There is, moreover, no history of traumatism, which, however, is absent also in idiopathic tetanus. In most cases of strychnia poisoning, death or recovery occurs within a short period; and there can usually be elicited a suspicious history of suicide or homicide.

Prognosis.—Tetanus arising within nine days of the time of injury is almost invariably fatal. Recoveries from tetanus, which are rare, are usually instances of the disease that have arisen nine days or more after the receipt of injury, and that have shown symptoms of but moderate violence. If the patient survives the fourteenth day of tetanus, recovery may be expected. High temperature is an unfavorable symptom.

Treatment.—Although the death-rate of tetanus is very high, treatment that lessens peripheral irritation and diminishes spinal excitability always palliates suffering, and may at times be followed by cure. The patient should be kept in a quiet, darkened room, free from draughts of air, and should be supplied with concentrated liquid food because of the exhaustive character of the disease. Food can be introduced by a flexible

tube passed between the cheek and the teeth, so that the liquid may enter the mouth behind the molars; or by a similar tube passed into the pharynx through the nostril. Usually, however, there are crevices between the teeth which admit the entrance of milk or soup. Such alimentation is preferable to rectal feeding, though the introduction of partially digested liquid food into the rectum may be valuable. Freedom from noise may be obtained by putting cotton in the patient's ears.

Iron, quinine, and stimulants may be desirable to sustain the failing powers. Laxatives or enemas may be required. Active purgation is injurious. The best remedy to control reflex excitability is, in my opinion, hydrate of chloral, which should be given in ten or twenty grain doses every one, two, or three hours. These doses may be increased if the patient does not become quiet and sleep. I have had good results follow this treatment, but it must be admitted that the cases were not of the most violent type. Extract of physostigma (gr. j every two hours and increased), or its active principle, eserine, hyoscine, urethan, etc., are worthy of consideration if chloral in large doses does not seem satisfactory. These remedies should be given early, and in doses as large as experience shows can be tolerated before resorting to other drugs. Chloral has been successfully used by enema, and eserine is very readily administered by hypodermic injection. Opium has some reputation in the treatment of tetanus, but it is probably better to use it as an adjunct to the chloral, to relieve pain. Bromide of potassium, cannabis indica, conium and similar substances, and the inhalation of anæsthetics have been advocated.

Hammond strongly recommends, in addition to internal treatment, the application of the ice-bag to the spine. Local measures should be adopted to prevent peripheral irritation. The wound should be freed from foreign bodies impacted in it, made aseptic, and dressed with antiseptic gauze. Stretching, incision, and excision of the nerve trunks have been employed, as has amputation, with varying results. When the nerve supply cannot be definitely fixed it has been proposed to make a deep incision down to the bone and thus divide all the nervous filaments. All these operations are regarded as of doubtful expediency by most authorities, though they are, perhaps, justifiable in such a hopeless condition. As such operations cannot be resorted to until tetanus has arisen, and as the symptoms probably depend upon a microbic cause, I doubt the utility of their performance. Neurectomy is apparently the most judicious procedure if any operation is done. Tracheotomy has been advised to meet the possibility of death by laryngeal spasm.

Hydrophobia.

Definition.—Hydrophobia is a disease of fatal prognosis, characterized by sudden spasm of the respiratory muscles upon attempts at deglutition and by other nervous phenomena, and which is generally believed to be a blood disease due to inoculation with a specific virus contained in the oral secretions of rabid animals, though there is some evidence suggestive of the symptoms being manifestations of central nervous disease, initiated in traumatic cases by the peripheral irritation of the injured nerve branches.

Cause.—If the generally accepted theory be correct, the cause of hydrophobia is a peculiar poison contained in the secretions of the mouth of animals affected with rabies. The disease is believed to be generated

spontaneously only in the canine family, in the cat, and a few other animals; but it can be communicated by inoculation to others, whose oral secretions then become virulent. It has not been proved that it can be communicated from one human being to another. Innoculation with other fluids of affected animals does not produce the disease. It has been suggested that bites by female animals in heat are, perhaps, more likely to cause hydrophobia than those of males or females under other circumstances. Microörganisms have been described as found in the secretions from the mouths of rabid animals, and to these fungi the communicability of the disease has been attributed. Many persons bitten by rabid dogs experience no unusual sequences, possibly because the saliva was absorbed by the clothing through which the injury was inflicted.

Another theory of the obscure disease called hydrophobia is that it is a reflex neurosis; in other words, that the wound, for hydrophobic symptoms are usually consecutive to a wound, causes irritation of the peripheral nerves, which, in turn leads to molecular and vascular changes in the medulla oblongata and pons Varolii.

If this theory is true, it follows that hydrophobic symptoms can probably occur after other peripheral irritation than that of bites of rabid animals. In fact they could arise when no injury had been received, provided the necessary changes in the medulla oblongata and pons Varolii were incited. There is some evidence that seems to point in this direction.

Pathology.—Changes, such as congestion, extravasation, softening, and granular degeneration have been found in the medulla oblongata, cord, and brain of patients dying with hydrophobia. These lesions are apt to be conspicuous in the medulla oblongata and its vicinity. They may, however, be secondary, and not the essential morbid changes of the disease. In some instances chronic alterations have been discovered in the nervous centres, which may have been the cause of the susceptibility to hydrophobic symptoms when peripheral irritation was induced. These cases seem to support the second theory of the nature of hydrophobia.

Symptoms.—Rabies is first exhibited in dogs by listlessness followed by restlessness, but there is no disposition to bite. Afterward the animal may become excited, as is exhibited by barking in a hoarse tone and snapping at the air, biting and licking sticks and stones; or he may show symptoms of melancholy and refuse to eat, drink, or observe his surroundings. Paroxysmal excitement, spasm of respiration and deglutition, protruding tongue and constant escape of saliva from the mouth, paralysis of the legs, convulsions and tremors may precede death. Rabies is not more common in summer than in other seasons, nor do mad dogs have the dread of water which is exhibited by men with hydrophobia. Much of the animal's excitement is doubtless in many cases due to his being chased by persons desirous of destroying him.

In man the period of incubation is usually, it is said, not longer than seven months. Cases have been reported when only a few days elapsed, and others are recorded in which no symptoms were shown until years had passed. Many of these cases will not bear searching investigation.

The wound made by the teeth of the rabid dog usually heals readily; but may, just before the advent of the general symptoms, become the seat of stinging pain or of inflammation.

The initiatory symptoms are physical and mental discomfort, stiffness of the throat and tongue, anxiety and irritability of disposition. Then occur spasms of muscles of deglutition and respiration, especially when

attempts at swallowing water and other fluids are made. This symptom gives the name to the disease. Solids are swallowed more readily than fluids. Cutaneous and sensory hyperæsthesia, wild delirium, convulsed features, hawking and spitting of an abundant viscid fluid, attacks of suffocation caused by drafts of air and attempts at deglutition, hoarse cough, sleeplessness, maniacal excitement, and at times paralysis, or general tetanoid or epileptoid convulsions complete the distressing picture. The pulse is frequent, the temperature high, and the urine often albuminous or saccharine. Death occurs from spasm or exhaustion about the third day.

It is said that dread of water is not always present, and that this symptom may occur in other affections.

Diagnosis.—Hydrophobia sometimes much resembles tetanus, and, indeed, a variety of the latter disease has been described as hydrophobic tetanus. The differential diagnosis of tetanus and hydrophobia has been discussed in the preceding article. Hysteria may assume the aspect of hydrophobia, but there is a want of consistency in the symptoms and an absence of high temperature. Moreover, the hydrophobic patient tries to conceal his fears from his friends, while the hysterical one endeavors to call attention to them. Hysterical hydrophobia is developed soon after the injury.

Treatment.—The preventive measures, to be adopted after an injury has been inflicted by the teeth of a mad dog or other animal is the immediate excision of the tissues around the wound, or suction followed by cauterization with strong nitric acid, or better with the red-hot iron. The application of a tight bandage to the limb above the wound until excision or cauterization has been effected is proper. The fears of the patient may be allayed by these precautions, even if the time elapsed has been too considerable to give an opportunity to prevent absorption by such means. I believe the application of nitrate of silver to be perfectly valueless. The animal should never be killed, but kept in confinement that the existence of rabies may be verified or disproved. Bromide of potassium in large doses has been recommended during the period of latency. When the symptoms have appeared, treatment, as a rule, exerts little influence in averting death. Nourishment and perhaps stimulation by the rectum, ice to the spine, perfect quiet and freedom from excitement are indicated. Worara (grain $\frac{1}{12}$ to $\frac{1}{6}$) or pilocarpine (grain $\frac{1}{8}$ to $\frac{1}{4}$) given hypodermically, nitrite of amyl or chloroform by inhalation, chloral, morphine and bromide of potassium, hyoscine hydrobromate, and similar remedies may be tried, but must be employed in large doses.

Pasteur has shown that dogs and some other animals may be protected from rabies by inoculation with attenuated virus of rabies in much the same way as men are protected from smallpox by vaccination. He has asserted that human beings who have been bitten by rabid animals may be protected from the disease by a similar preventive inoculation. His views have not as yet been accepted by the entire medical world.

Traumatic Delirium Tremens.

Definition.—This is a nervous affection characterized by muscular tremor and a peculiar restless delirium, which not infrequently follows the receipt of injuries by those accustomed to alcoholic stimulation.

Causes.—Some writers under the terms traumatic delirium and nervous

delirium describe a condition, frequently very similar to delirium tremens, which is said to occur in patients free from the alcohol habit and to depend upon nervous prostration, often associated with shock and hemorrhage. It is possible that failure to investigate previous habits with judicial acumen has allowed to arise a confusion between delirium dependent simply upon traumatism and delirium induced by traumatism in alcohol drinkers. The muttering delirium and muscular twitching that supervene in nervous prostration or asthenia from surgical as from medical causes, and the noisy delirium after injury, that is usually exhibited by quick, rapid, and full pulse and by febrile reaction, are two very different conditions to which the name traumatic delirium may with propriety be applied. These forms of mental disturbance—better in my opinion called, in the one case, nervous or asthenic traumatic delirium, and, in the other case, septic or inflammatory traumatic delirium—arise without reference to personal habits. These two conditions are possibly often intermingled with alcoholic traumatic delirium or traumatic delirium tremens, as I here term it.

The group of symptoms which I propose describing as traumatic delirium tremens, is found especially, if not exclusively, indeed, in those whose nervous systems have undergone, prior to injury, the deterioration due to absorption of alcohol. I have not been convinced by my experience, which I admit to be somewhat limited, nor by my reading that such a concatenation of symptoms can occur after traumatism in the absolutely abstemious. The amount of drinking requisite to induce the predisposition varies with the individual. The repeated ingestion of quite small quantities of alcohol may give rise to the delirious susceptibility. It is possible that a similar deterioration of constitution and consequent liability to trembling delirium may be caused by the opium, chloral, tobacco, and other similar habits; but it is difficult to differentiate these, because of their frequent association with alcoholic excess.

Traumatic delirium tremens may follow even slight injuries, but compound fractures and burns seem to have a special tendency to develop this serious complication. Its occurrence should not be ascribed to the restraint imposed upon the patient's habits by the injury, but to a traumatic disturbance of a previously unstable nervous equilibrium. The medical authorities vary in their appreciation of the causative influence exerted by sudden deprivation of accustomed stimulants in exciting attacks of ordinary delirium tremens. It is probable, however, that in a vast majority of such cases the directly exciting causes are the deficient assimilation of food, the anxiety and the nervous strain which go hand in hand with a period of debauch, and which persist after the ingestion of alcohol is stopped. Neither is the recurrence of the malady to be imputed to the directly poisonous effect of a large amount of consumed alcohol, since acute alcohol poisoning in persons unaccustomed to the use of alcohol gives rise to stupor and death, but not to delirium.

Traumatic delirium tremens occurs because obscure chronic changes in the nervous tissue or blood, or perhaps in both, have rendered the alcohol drinker susceptible to such an outbreak upon the application of any disturbing influence. The receipt of injury is a sufficiently perturbing force, especially if the patient be on the verge of an idiopathic attack. It has been thought that the use of beverages containing amylic alcohol (fusel oil), especially predisposes to delirium tremens.

Pathology.—The alteration in nerve structure or blood, which is the essential pathological factor of delirium tremens, is unknown to us. An

abnormal amount of serum is usually found in the substance and within the ventricles of the brain, meningeal congestion and hemorrhage are often seen; the cells of the gray matter, the cerebral connective tissue, lymph spaces and vessels show sclerotic or fatty changes, and the liver, kidneys, and digestive tract exhibit the characteristic lesions found in chronic alcoholism, but there is nothing to which we can point as the distinctive lesion of delirium tremens.

Symptoms.—The initiatory symptoms of traumatic delirium tremens are sleeplessness at night and slight tremor, which is readily noticed by ordering the patient to hold out the hand with widely distended fingers. Subsequently restlessness, insomnia, and tremor increase, and delirium is shown.

The delirium, which is often first exhibited at night, is peculiar. The patient sees numerous small animals or insects creeping over the bed and about his person, or is pursued by some hideous spectre. Hence, he is constantly endeavoring to eject the vermin from his clothing, or trying to escape the persecutions of his tormentor. He may, in his efforts to get rid of these disgusting and distressing annoyances, leave his bed and fall from a window or down a flight of steps. The mental condition is one of depression, trepidation, and great activity. He is exceedingly restless, and is constantly chattering in a low tone; but though he may cry out because of fear, he shows little or no maniacal excitement. He is good-natured. not prone to violence, and can often be aroused by emphatically spoken words to an understanding of his surroundings; but he soon relapses into the previous incessant chattering and motion. Very often a single idea recurs again and again to his delirious fancy, and not infrequently the delirium has a comical or tragico-comical aspect. The muscular tremor is not like the twitching of tendons seen in asthenic conditions, but resembles the shakiness, from want of coördination, seen in cerebro-spinal sclerosis. Often there is hurry in movement, and the limbs or tongue will then be thrust forward with a jerk. The tremor of delirium tremens reminds one much of the movements that would be expected in an association of chorea with sclerosis of the nervous centres.

During these symptoms the patient is unable to sleep, is incessantly in motion, and has a bright eye with dilated pupils and an unsteady, restless look. He exhibits a moist, flabby, tremulous tongue, with a whitish fur; desires no food; has constipated bowels, and passes a scanty, high-colored urine. In idiopathic delirium tremens of moderate severity there is no great acceleration of the pulse, and the temperature does not rise much above 100°, except during active muscular exertion. In those graver cases, which Magnan calls febrile delirium tremens, the bodily heat is apt to remain in the neighborhood of 102°–105°, though there is no incurrent affection to keep up the temperature, and the pulse rate is also increased. In traumatic delirium tremens the constitutional disturbance, due to the wound, affects the pulse and temperature. The patient will often remove the dressing from his wound, or subject the injured limb to violent motion without appearing to experience pain.

Traumatic delirium tremens, as a rule, arises within two or three days after the receipt of injury and lasts usually not more than five or six days. The illusions are apt to continue during the night, even after the patient has become convalescent and quite rational in the daytime.

Diagnosis.—The peculiarity of tremor and delirium renders the diagnosis easy, except from the condition called above nervous or asthenic traumatic delirium. The existence of the described symptoms is, there-

fore, not absolute evidence of previous habits of stimulation, since it is possible that great nervous strain prior to injury may lead to a similar delirium. Usually, however, alcohol seems to be the predisposing cause, though it is not always wise to mention the suspicion, nor to call the disease delirium tremens, since the patient's friends may be unaware of the existence of such habits.

PROGNOSIS.—Death may occur from exhaustion, coma, or some intercurrent affection; and is sometimes inexplicably sudden. The character of the traumatism may determine the mode of death. Pneumonia is frequently associated with delirium tremens. It is often, in fact, the existing cause of the delirious outbreak, and, of course, in traumatic cases greatly diminishes the chances of recovery. When the temperature shows a tendency to remain high without a sufficient traumatic cause, and especially when the tremor affects all the muscles of the trunk as well as those of the head and extremities and is not arrested during sleep, the prognosis is bad.

A history of previous attacks of the disease renders the outlook more grave.

TREATMENT.—It is important to bear in mind that delirium tremens is an asthenic condition. There is action, but it is the activity of weakness not of power. Depressants are, therefore, injurious. Five or ten grains of calomel or one or two Seidlitz powders may be administered in the beginning of the disease, or when its occurrence is feared, because of the anorexia and gastric derangement.

Concentrated liquid food with bitter tonics and capsicum add to the patient's strength and tend to give tone to the impaired digestive organs; bathing, Turkish baths if possible, and mild diuretics may be prescribed in the endeavor to eliminate the alcohol that has entered the system. Hydrate of chloral (gr. x–xx) with bromide of potassium (gr. xxx–xl) should be given every two or three hours as soon as sleeplessness and slight tremor is noticeable. No visitors should be allowed in the room. If the development of the attack is not prevented, the same treatment is continued, but the dose may be increased. The object is to quiet the nervous system and produce sleep. In this endeavor an occasional dose of morphia (gr. $\frac{1}{4}$–$\frac{1}{3}$) may be combined with the chloral and bromide of potassium. The excessive use of opiates is undesirable for it is not narcotism that is desired, but sleep. Cerebral congestion is induced by overdosing with morphia. If fatty heart exists opiates should be pushed, perhaps, rather than the chloral and bromide of potassium. The combination treatment by the three hypnotics allows the surgeon to diminish or increase each element according to indications. Tincture of digitalis (♏x–♏xxx) is valuable in cases of weak but not fatty heart, where there are pallor and cyanosis with probable anæmia of the brain. Strychnia has been recommended in delirium tremens. Hyoscine hydrobromate (gr. $\frac{1}{100}$) and other hypnotics may prove serviceable.

Mechanical restraint with straps and the straight-jacket is only to be adopted when efficient watching and soothing by attendants are impracticable. All such apparatus excites the patient and is very liable to interfere with respiration. The best appliance is a loose, but strong, garment consisting of trousers and shirt in one piece, with loops attached for fastening the patient in bed. Fractures should be dressed with plaster-of-Paris bandages, because ordinary splints will probably be displaced by the patient. If failure of vital powers is to be feared, alcoholic stimulants in small amounts, administered only when food is given, are judi-

cious, because in chronic drinkers digestion will sometimes not go on efficiently without the aid of alcohol. The failure of assimilation in delirium tremens may turn the scale against the patient. Whiskey or brandy (f℥ij to f℥iv daily) in the form of milk punch or eggnog is probably the best form of administration. Many patients will not require any stimulants whatever.

Vomiting occurring in delirium tremens is to be treated by milk and lime water, cracked ice, effervescing drinks, subnitrate of bismuth, pepsin, and carbolic acid mixtures.

Nervous traumatic delirium is to be treated by bromides, chloral, hyoscine, and nerve tonics, and presents a favorable prognosis.

Septic or inflammatory traumatic fever requires judicious antiseptic treatment to combat the local infection with septic products; cold to the head and hypnotic remedies. It occurs when the septic fever is at its height and is often more conspicuous at night; resembling in this latter respect alcoholic traumatic delirium.

CHAPTER XVI.

DISEASES AND INJURIES OF THE HEART AND BLOODVESSELS.

DISEASES AND INJURIES OF THE HEART AND PERICARDIUM.

Wounds of the Pericardium and Heart.

PUNCTURES and small incisions of the pericardium, if uncomplicated with injury to the internal mammary artery, heart, or lungs, present no marked symptoms, and are usually soon repaired by a local pericarditis. Such wounds are made almost with impunity in treating pericardial effusions by aspirations and incision.

Larger wounds are much more serious by reason of the suppuration that is liable to occur and the involvement of neighboring structures. The treatment of pericardial wounds consists in rest, antiseptic dressings, and, if suppuration takes place, free exit for the pus by incision, drainage and frequent irrigation. If pericardial effusion occurs after a contusion or laceration of the membrane, blisters, diuretics, and hydragogues should be employed as in rheumatic pericarditis. If the effusion persists and the symptoms become urgent, pericardicentesis should be performed.

Wounds of the heart are generally, but not necessarily, fatal. Patients have survived many years with foreign bodies buried in the cardiac walls. The diagnosis is obscure, though signs of internal hemorrhage, or profuse external bleeding with syncope, or great shock, with irregular and feeble action of the heart occurring after a wound of the pericardium make it probable that the heart has been injured.

Small cardiac wounds may not be followed by much bleeding, because the peculiar interlacing of the muscular fibres causes the opening to be closed as by a valve. In other cases the pericardium may become filled with blood to such an extent as to make the cardiac sounds and beat almost imperceptible. Death may arise from interference with the heart's action in this manner when the wound itself is not necessarily fatal. The hemorrhage from the heart may be slow or be arrested by a clot forming in the orifice. This may be washed out when reaction from shock occurs and secondary hemorrhage and death thus take place. Men may even walk after wound of the heart. Dyspnoea, pain, pericardial distress, and a systolic-bellows sound have been observed in heart wounds, but these symptoms and signs are not always present.

It should be remembered that the heart lies obliquely between the upper margin of the third costal cartilage and the top of the sixth cartilage, and that it extends from a line about one inch inside of the left nipple to a point a little beyond the right margin of the sternum. Wounds of the auricles are more dangerous than similar injuries to the ventricles.

Wounds of the heart must be treated by absolute rest in the supine position, by cold to the front of the chest, morphia, atropia, and digatalis. When it is certain that clots in the pericardium are doing harm, incision of that sac, removal of the clots, and antiseptic injections may be advan-

tageous. Experimental suture of the heart has been done successfully, it is said, in the lower animals. I should not hesitate to open the pericardium and attempt to suture a heart-wound in the human subject, if evidence of such a wound was strong. Resection of the costal cartilages might be necessary in order to gain access to the parts.

Tapping the Pericardium or Pericardicentesis.

In pericarditis with effusion, and in cases of hydropericardium from renal disease, the pressure exerted upon the heart by the accumulated fluid is at times a mechanical cause of death. Hence, it may become necessary to withdraw the fluid by aspiration. In all cases of pericardial effusion which present dangerous symptoms of heart failure, aspiration should be performed as soon as it is evident that medication is not lessening the embarrassment of the central organ of circulation. It is bad practice to delay operation until exhaustion, pulmonary engorgement, and degeneration of the cardiac muscle render permanent relief impossible. A moderate quantity of serum suddenly effused will exert more pressure on the heart than a much larger amount poured out in so gradual a manner as to allow the pericardium to become stretched. Hence, the symptoms, and not the amount of serum, must be the guide to operation.

If there coexists pleural effusion of considerable amount, the pleural sac should be aspirated first, because it is difficult to discriminate between respiratory distress due to pulmonary pressure and that resulting secondarily from interference with cardiac action. This rule applies to pleurisy of the right side as well as of the left.

When the amelioration of symptoms following pericardial aspiration is not permanent, because reaccumulation takes place, the operation should be repeated. It is better to vary the point of puncture, lest, on account of adhesion of the layers of pericardium at the original point, the heart be wounded at the second tapping. Should repeated tapping be demanded, I should be inclined, after the third operation, to inject some irritating fluid, such as tincture of iodine, into the sac, with the idea of producing adhesion of the two layers of pericardium.

When aspiration has shown the pericarditis to be distinctly purulent, it is practically certain that repetition of the operation will be demanded. In such an event the introduction and retention of an antiseptic rubber drainage-tube, after a free incision has been made, strike me as the most judicious kind of surgery. The cavity can be washed out daily with antiseptic solutions, and purulent accumulation with its attendant dangers of pressure on the heart and septicæmia avoided.

Incision may be useful in certain cases as a diagnotic procedure, when doubt exists as to the condition being dilated heart or pericardial effusion.

The best point for aspiration[1] of the pericardium is in the fifth interspace, just above the sixth rib, about five or six centimetres (2–2½ inches) to the left of the median line of the sternum. In a child it should be nearer the sternum. The ordinary aspirating needle or the aspirating trocar which I have devised may be employed. In all cases the vacuum chamber should be attached to the puncturing instrument as soon as its point is buried beneath the skin, in order that the flow of fluid may indicate the moment when the pericardium is entered.

[1] Paracentesis of the Pericardium, by John B. Roberts. Philadelphia, 1880.

The pericardial aspirating trocar recommended consists of a moderate size aspirating needle, within which slides a canula with a flexible end. During penetration of the chest wall the canula is retracted, so that the

FIG. 81.

Roberts's aspirating pericardial trocar.

flexible end is contained within the needle. Afterward it is thrust forward to guard the sharp point of the needle and prevent scratching of the heart's surface when withdrawal of the fluid causes the pericardial sac to collapse.

DISEASES AND INJURIES OF THE ARTERIES, VEINS, AND CAPILLARIES.

Hemorrhage.

DEFINITION.—An escape of blood from the vessels is called hemorrhage, and is either spontaneous or traumatic. When the blood is discharged, not upon the surface of the body or into a cavity, but into the meshes of the connective tissue, the term extravasation is generally used. An extravasation into the connective tissue beneath the skin is often designated a subcutaneous hemorrhage.

VARIETIES.—Traumatic hemorrhage is primary when it immediately follows the receipt of wound; intermediary when it occurs after reaction from the shock of injury, and before the lapse of twenty-four hours; and secondary, when it takes place between the end of the first twenty-four hours and the completion of cicatrization of the wound.

Intermediary, often called recurring, hemorrhage arises because the force of the circulation has, from the establishment of reaction, become sufficient to displace the clots which, during the previous condition of feeble circulation, prevented bleeding.

It may, therefore, occur from small vessels that did not, at the time the wound was dressed, seem to demand ligatures or other treatment; or from larger ones to which ligation, torsion, or acupressure was carelessly or imperfectly applied, or in which the wound was so small that no hemorrhage supervened until the circulation had fully regained its force.

Secondary hemorrhage may be due to any constitutional condition, such as hematophilia, septicæmia, pyæmia, hepatic disease, and renal disease, which interferes with the plastic changes and organization of the internal clot that constitute Nature's method of permanently sealing wounded vessels. Hence, when the ligature is absorbed, or the wall of the vessel ulcerated through at the point of ligation, bleeding supervenes.

Secondary bleeding may also be caused by an unrecognized contusion or abrasion of the vessel wall which has subsequently given away at the injured spot, by failure of the surgeon to secure the distal end of the artery or to tie a wounded branch situated just above the ligature. In the last two instances the establishment of the anastomotic circulation may be followed by bleeding. Sloughing in the wound, atheroma of the arterial wall, septic processes due to septic ligatures or dressings, badly applied ligatures, premature softening of a ligature, and the rush of the

blood-current through a large branch given off just above the point of ligation are frequent cause of secondary hemorrhage. Secondary bleeding usually does not occur earlier than one week, or later than three weeks after the time of injury or operation. Septic causes are responsible for the majority of cases of secondary hemorrhage. Aseptic surgery has almost made secondary hemorrhage unknown. This serious complication must, therefore, be carefully provided for about the fourteenth day, especially after ligation of arteries in continuity for aneurism. In such cases the secondary hemorrhage is more apt to occur at the distal than the cardiac side of the ligature, because internal coagulation and cellular changes occurring there are less effective than in the proximal or cardiac portion of the artery, and probably, also, because the ligature interferes with the small vessels supplying the arterial coats below the seat of constriction. The rapid healing of wounds under aseptic and antiseptic treatment has made secondary hemorrhage much less frequent than formerly.

The occurrence of profuse secondary bleeding is generally preceded by a slight flow of blood, which, when observed during the progress of cicatrization or suppuration, should always be looked upon as a warning of grave import. There may be several slight hemorrhages from the wound, and then, when the surgeon flatters himself that he has nothing further to fear, a profuse bleeding quickly destroys the enfeebled and anæmic patient. The treatment of secondary hemorrhage is of exceeding importance, and will be considered after the discussion of the treatment of primary bleeding.

Blood starts from a wounded artery in a rapid stream, and, as each beat of the heart gives an increased impulse to the blood-current, the jet gains force, and is propelled further synchronously with the cardiac pulsations. The blood is of a bright-red color, unless the patient is deeply anæsthetized or partially asphyxiated; then respiration and oxygenation are imperfectly performed, and the blood is dark. When an artery has been completely divided, the hemorrhage from the end further from the heart may not be rhythmical until the collateral circulation is well established.

Venous hemorrhage is characterized by a steady flow of dark blood, which is not affected by the heart's action. The stream may show a tendency to rise and fall in a sluggish manner with each respiratory act, but never spurts. If the bleeding occurs at the bottom of the wound the blood may become reddish from admixture with air before it reaches the surface.

Hemorrhage from capillary vessels, called parenchymatous hemorrhage, occurs as an oozing of blood. The steady stream has a color less red than arterial and less purple than venous blood.

Causes.—Solution of continuity of vascular walls is the common cause of hemorrhage, but bleeding does occur at times from mucous and serous surfaces without apparent lesion. Here the quality of the blood is probably at fault. Cirrhosis of the liver and poisoning by phosphorus and some other substances are said to cause this form of blood transpiration. It must be recollected that hemorrhage from any part may be vicarious to menstruation or other customary loss of blood.

Constitutional Effects of Hemorrhage.—It is exceedingly important that the surgeon should recognize the general symptoms of hemorrhage. In certain cases no blood is visible externally, though a sufficient quantity to cause fatal anæmia has been poured out into the intestines, uterus, or abdominal cavity; or into the cellular tissue surrounding the

perforated vessel. Such concealed hemorrhages are to be recognized by the constitutional effects produced by the withdrawal of blood from the vascular channels.

The general symptoms of hemorrhage are influenced by the constitutional characteristics of the patient and the vessel from which the blood flows, but depend more especially upon the quantity of blood lost and the rapidity of its escape. An insignificant bleeding may prostrate even to syncope a debilitated or frightened subject, while a considerable hemorrhage will in some others give rise to no prominent symptoms. Children and the aged are very impressible by loss of blood. Arterial hemorrhage may be expected to produce greater depression than a similar loss from veins, for the obvious reason that venous blood is, in a certain degree, an effete fluid.

When a violent and profuse gush of blood occurs from rupture of a large arterial trunk, death is rapid. The blood in all the arteries has a recurrent tendency, and, instead of being forced by arterial and cardiac contraction into the peripheral vessels, it flows toward the wound; hence there is a consequent venous stagnation which gives a livid tinge to the otherwise pallid surface. The patient, who has fallen to the ground in a state of syncope, gasps for breath, throws his limbs about restlessly, and, after convulsive twitchings of the facial and other muscles, expires. Profuse hemorrhage from a large venous trunk causes death in a somewhat similar manner. A less impetuous loss of blood, whether arterial or venous, causes a feeble and rapid pulse, sighing respiration, pale conjunctivæ and lips, a cold clammy skin, dilated pupils, restlessness, and a confused mind. The patient feels weak and thirsty, is giddy, has impaired vision and hearing, or, perhaps, sees luminous spots or hears unusual noises, experiences a sense of suffocation, but feels no special pain, and rather suddenly loses consciousness. During this state of syncope the breathing is almost entirely diaphragmatic, and the heart's pulsation can scarcely be detected. This lowering of circulatory tension gives an opportunity for coagulation in the wounded vessel, and the bleeding is arrested. The patient now recovers from the condition of insensibility, and, perhaps, vomits as he returns to consciousness. The increasing force of the heart's action, however, is soon sufficient to cause the blood-current to force the clot from the interior of the injured bloodvessel, and hemorrhage, with the train of symptoms mentioned above, recurs. This alternation of bleeding and spontaneous arrest is kept up until death occurs from anæmia of the nervous centres. Sometimes delirium, convulsions, and hemiplegia precede the fatal termination. In very slow hemorrhage there arises great debility, with waxy-looking skin, œdema of the dependent parts, and a tendency to syncope on assuming the erect posture.

After death from prolonged or repeated hemorrhage the tissues are soft and flabby, because the fluids have been absorbed to fill the emptied bloodvessels. This explains, also, the thirst felt by the patient. After serious hemorrhages have been stopped a stage of reaction often supervenes, to which the name hemorrhagic fever has been applied. The symptoms are febrile manifestations and a frequent, quick pulse, accompanied by irritability and restlessness of mind and body. Occasionally hemorrhage is followed by a chronic anæmia, which is extremely rebellious to treatment. The febrile state, above mentioned, is to be met by rest, sponging the surface, cold to the head, nutritious fluid food, and tonic remedies.

Nature's Mode of Arresting Hemorrhage.—Obscure is the means by which spontaneous cessation of hemorrhage is determined in those unusual cases of oozing, without apparent lesion of the bleeding surface, which have been mentioned.

Hemorrhage, from vessels in whose walls a solution of continuity has been produced by accident or operation, often ceases spontaneously. It usually does so in veins, except those of great calibre, and in arteries smaller than the radial and facial. The method employed by Nature in arresting hemorrhage is the same in arteries and veins, though in the latter the sluggish blood-current does not demand such active contraction and retraction of the walls of the vessel.

When an artery has been completely divided, Nature promptly institutes steps, which are intended to cause a temporary arrest of the escape of blood until a permanent occlusion of the open extremity can be accomplished. The same series of changes occur in both the cardiac and distal ends of the cut vessel. The *temporary* means consist of: (1) Contraction and retraction of the cut end; and (2) clotting of the escaping blood in and around the sheath of the vessel.

The *permanent* means are: (1) The formation of a clot within the artery; (2) plugging of the orifice and union of the edges of the cut extremity by the ordinary process of repair; and (3) cicatricial contraction of the walls of the vessel by which an impervious fibrous cord is produced.

Temporary Means.—The contraction of the walls of the vessel, which extends up to the first branch, gives its section a flattened or ovoid shape, and, by diminishing the calibre, lessens the size of the blood-stream. At the same time, the retraction of the cut end of the artery within the sheath leaves a space between it and the wound in the non-retractile sheath, which detains the escaping blood and encourages coagulation. Coagulation also takes place outside of the wounded sheath. Lacerated vessels, by the irregularities of the torn ends and of the sheath, encourage this clotting, and may even, if large, soon stop bleeding.

Fig. 82.

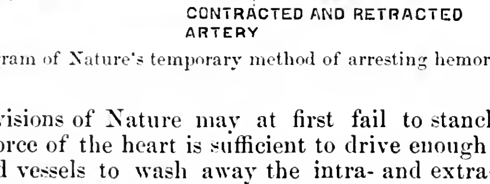


Diagram of Nature's temporary method of arresting hemorrhage.

These provisions of Nature may at first fail to stanch the bleeding, because the force of the heart is sufficient to drive enough blood through the contracted vessels to wash away the intra- and extra-vascular clots. As the continuing hemorrhage increases the coagulability of the blood and weakens the cardiac power, perhaps to syncope, the time arrives when these temporary expedients of Nature stop the flow. Cardiac strength then returns and may, by the increased intravascular pressure, cause recurrence of the bleeding. In many instances, however, the tem-

porary means are effective until permanent changes can be brought about to repair the vascular traumatism.

PERMANENT MEANS.—When a temporary check has been given to the flow of blood, a coagulum gradually forms within the artery. This is conical in shape, with its base situated and fixed at the opening, while its apex, lying loose in the lumen of the artery, extends as high as the first branch. The base of this internal clot corresponds in size with the interior of the vessel, which it fits like a cork.

FIG. 83.

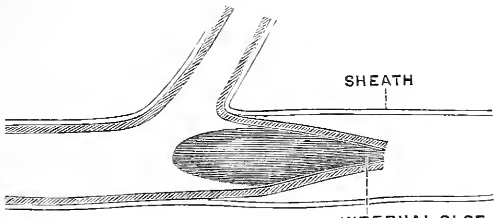


Diagram of internal clot formed in Nature's method for the permanent arrest of hemorrhage.

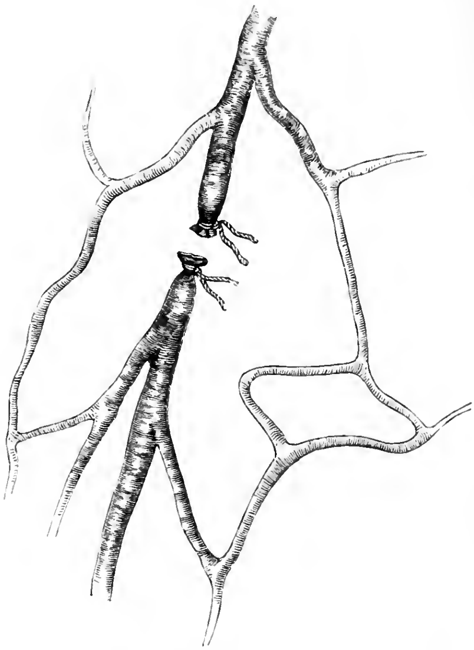
After the deposition of this internal coagulum, and sometimes without its formation, for it may occasionally be absent, an exudation of inflammatory lymph occurs in the stump of the artery and around it and the sheath. This plastic material unites the edges of the wound and seals the orifice by a button-like plug of exudate. The internal blood coagulum is at its base more or less intimately associated and commingled with the plastic deposit. Organization of the exudate, disappearance of the blood-clot, and permanent cicatricial contraction of the vessel to the first important collateral branch go on until finally from the first branch above nothing remains but an impervious fibrous cord.

Hemorrhage from a wound partially dividing an artery is controlled in a similar but not identical manner. Contraction and retraction of the vessel cannot occur; but blood is effused within and around the sheath and thus, unless it rapidly escapes to the exterior of the body, causes pressure upon the wounded artery. This causes temporary arrest of the blood escape. An internal coagulum may then be formed. Lymph is subsequently effused, the cavity of the vessel is occluded, and fibrous metamorphosis with obliteration of the vascular channel is permanent. When the wound is less in extent than one-fourth the circumference of the vessel, or if it is longitudinal and consequently gapes very little, hemorrhage may cease and repair occur by plastic exudation, without much encroachment upon the lumen of the vessel. In such cases, however, the internal and middle coats are seldom firmly united, and the force of the circulatory current is very apt eventually to cause stretching of these tunics. Thus may arise traumatic aneurism.

COLLATERAL CIRCULATION.—When the passage of blood through an artery is arrested by division, ligation, or any form of obstruction, the parts beyond receive, at first, less blood. As a consequence, absence of pulsation, lowered surface temperature, and impaired muscular power result. Soon, however, the anastomosing branches and capillaries of the same and of the neighboring arteries dilate by a vital process and carry more blood to the part than is normal. This is shown by increased red-

ness and unnatural elevation of temperature, which, in the case of obstruction of large arteries, only occurs after the lapse of many hours. After a time the duty of supplying the distal region becomes relegated to a few branches, which remain permanently enlarged. The functions of the part are then carried on exactly as they were previous to interference with the blood-supply.

FIG. 84.



Collateral circulation after wound of artery and ligation.

The establishment of the collateral circulation necessitates a reversal of the blood-current in some vessels, but this is not opposed to physiological processes. In aged subjects, whose vessels are apt to be rigid and atheromatous, dilatation of the arteries and capillaries cannot always be rapidly and readily effected. Hence, in such subjects gangrene of the peripheral region from deprivation of blood is more frequent than in the young. The collateral circulation is usually effected by the anastomosis of the branches on the same side of the body and not by inosculation with branches coming from vessels across the median line. Thus, when the right common carotid artery is ligated, the exterior of the head is supplied by the inferior thyroid, a sub-branch of the subclavian, furnishing blood to the ramifications of the superior thyroid, a branch of the external carotid. The current in the superior thyroid is reversed, and the blood emptied into the external carotid, which carries it to the face and scalp. The interior of the head is nourished by the vertebral, a secondary branch of the subclavian, communicating within the skull with the cerebral branches of the internal carotid. Little dilatation occurs in the branches inosculating with the corresponding vessels of the left side.

When a vein is obstructed collateral circulation is readily established in a similar way. If there is failure in effecting this result, venous congestion and œdema occur in the parts below, and may be the cause of moist gangrene.

Hemorrhagic Diathesis.—In some persons a peculiar constitutional tendency, often inherited, causes profuse and almost uncontrollable bleeding from slight wounds, such as simple punctures and tooth-extraction. Spontaneous hemorrhage from the nostrils, kidneys, intestines, or bronchial tubes, and large extravasations into the cellular tissue after bruises, may occur in such subjects. Hemorrhagic diathesis or hematophilia is usually exhibited in childhood, and is frequently unknown until a trivial injury discloses its existence, for such patients often enjoy vigorous health. A liability to joint affections similar to rheumatism, and to inflammations of the lungs, has been said to coexist with the hemorrhagic diathesis. As age advances the bleeding tendency may disappear. In some instances there are attacks of spontaneous hemorrhage, though wounds may be inflicted with impunity in the intervals.

Males are much more frequent subjects of hematophilia than females. The cause of the condition is unknown. There at times appear to be deficient coagulability of the blood, and unusual thinness of the internal coat of the vessels.

The tendency to hemorrhage is to be combated by saline laxatives, iron, ergot, lead, and opium. Quinine in large doses has been recommended. All operations are to be avoided. If wounds occur and bleed, pressure by bandage, ligature, or acupressure must be employed. The actual cautery is a valuable local agent.

Treatment of Hemorrhage. *Constitutional Measures.*—Before referring to the local means of checking hemorrhage, the constitutional or general measures must be mentioned; though they are much less important. It is, in fact, only after the bleeding vessels have been controlled, or when hemorrhage is feared, but has not yet occurred, that general measures obtain much consideration. The patient should be kept quiet and recumbent, with the head low, in order to lessen the activity of the heart and prevent anæmia of the brain. Sudden elevation of the head may be followed by fatal syncope when much blood has previously been lost.

The supply of blood to the nerve-centres can be kept up, in those who have suffered collapse from profuse hemorrhage, by encircling the four limbs with rubber bandages, as in the bloodless method of operating. This drives the entire volume of blood to the head and trunk. The elastic pressure can be continued, as we know from experience in operations, for at least an hour without harm to the extremities thus deprived of blood. If several limbs are bandaged, it is well to remove the pressure slowly and from one at a time; lest the sudden rush of blood into the limbs cause recurrent anæmia of the brain. This process is called auto-transfusion, because the patient has his own blood forced into the centres of organic life. If rubber bandages are not at hand, flannel or muslin bandages may be used; or digital compression of the abdominal aorta or of the subclavian and axillary arteries will prevent the exit of blood to the limbs, and thus leave more for distribution to the head and trunk.

Morphia, quinine, ergot, gallic acid, lead and iron, in full doses, have been recommended as internal hemostatic remedies, but I have little faith

in them in surgical hemorrhages. The local treatment is far more important and effective.

In order to diminish arterial tension and thus hasten the arrest of blood, Detmold has suggested temporary withdrawal from the general circulation of some of the blood. This is accomplished by applying bandages around the upper arms and thighs with firmness sufficient to prevent venous return, but not so great as to interfere with the ingress of arterial blood. The limbs are thus engorged with blood which cannot return to the heart. Hence there is less blood-pressure at the point of hemorrhage, and spontaneous arrest is encouraged. This device is ingenious, and may perhaps be serviceable in inaccessible hemorrhage of the trunk and viscera.

Hemorrhage renders patients thirsty because of the draining of the liquids of the body. Hence water and liquid foods are acceptable and valuable. Perhaps water containing saline ingredients would be preferable to simple water. Tonics, stimulants, and concentrated diet should be administered subsequent to profuse hemorrhage, to replenish the loss of the vital fluid.

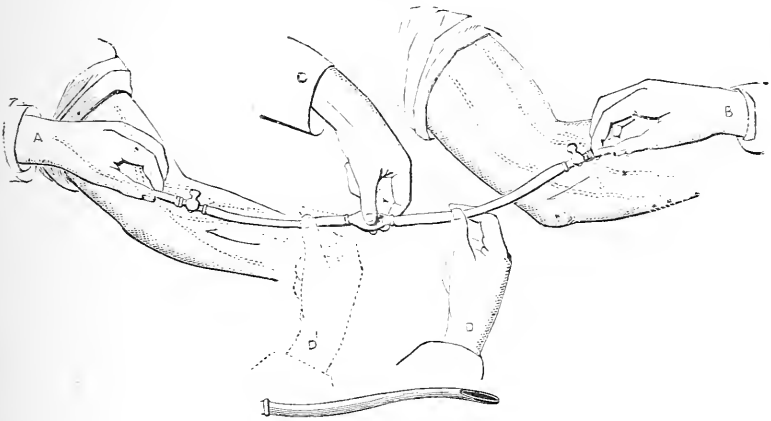
Transfusion.—When death from violent hemorrhage is imminent, transfusion of blood taken from another person who is vigorous and healthy is proper. Venous or arterial blood may be used, and it may be injected into a vein or an artery. Venous blood is generally preferred, because more readily obtainable, and is usually transfused into a vein of the arm. If the blood is transfused from the donor to the receiver without being subjected to manipulation, the operation is direct transfusion. The indirect method consists in drawing the blood into a receptacle, removing the fibrine by whipping, and, after straining the defibrinated blood, injecting it by a syringe into the circulation of the patient.

In performing the operation it is important to avoid the injection of portions of clot, and to prevent the entrance of air into the patient's circulation. The quantity of blood transfused should not exceed eight or ten fluidounces, and should be injected very slowly. It is not unusual for a marked chill to follow the procedure.

Direct transfusion is readily accomplished by Aveling's apparatus. This consists of a rubber tube, with a bulb without valves in the centre, and metallic caps with stopcocks at each end; and two canulas or metal tubes for insertion into the veins of the donor and recipient. The canulas can be attached at will to the caps of the rubber tubes by an air-tight joint. When transfusion is to be done, the rubber tube and bulb are filled with warm water and the cocks turned to prevent its escape. The largest vein at the bend of the elbow of the patient is then opened by a flap incision made with a sharp bistoury, and a canula filled with warm water introduced into the vein with the point directed toward the patient's shoulder. The external opening of this canula must be closed by an assistant's finger to prevent escape of the water. A similar vein in the donor's arm is immediately opened and the other canula inserted with its point toward the hand. From this a little blood should be allowed to flow to drive out the air. The rubber tube, or syringe, filled with warm water is now attached to the two canulas and both stopcocks opened. The canulas must be held in place by assistants or by the veins being tied around them. The surgeon with a thumb and finger presses together the sides of the tube at any point between the bulb and the donor's arm, and then compresses the bulb. By this manœuvre the warm water in the apparatus (f℥ij) is injected into the patient's circulation. The thumb

and finger are then applied to the tube near the recipient's arm, and the bulb is allowed to dilate. Thus about two drachms of blood are sucked out of the donor's arm, and are, by a repetition of the previous process, thrown quietly and slowly into the vein of the patient. If the surgeon prefers, he can force the water out of the syringe and let it and the tube fill with blood before connecting the apparatus with the patient's canula. Then no water is transfused, except the very small amount contained in that canula.

Fig. 85.



Apparatus for direct transfusion.

Indirect transfusion is accomplished by withdrawing, as in ordinary venesection, about ten fluidounces of blood from the donor and receiving it in a small vessel surrounded by hot water (110°). The blood, thus kept warm, is deprived of its fibrine by whipping with a fork or bundle of straws. After being filtered through a cloth or strainer the defibrinated blood is slowly injected by means of an ordinary syringe attached to a canula, which has previously been inserted into the vein of the patient. The syringe and canula must have the air expelled. Elaborate apparatus has been devised for facilitating these steps, but it is not always possible to obtain such instruments when needed, and the simple means described is efficient.

In both modes of transfusion it is often preferable to isolate the patient's vein before opening it, and to apply a ligature around it and the point of the canula after the latter is placed in position. These procedures must be carried on under rigid asepsis.

Instead of human blood, lamb's blood, milk, and saline solutions have been transfused with some apparent benefit.

Local Measures.—In all cases of bleeding the first step is to clean the wound and remove the loose clots. Afterward that means of checking hemorrhage is selected which, while securing immunity from recurrence of bleeding, best assists Nature's efforts and offers least obstruction to rapid healing. When operating, the surgeon should bear in mind that many fluidounces of blood can be lost without very serious injury, and also that no artery or vein can bleed if it is compressed by the fingers. These facts give assurance that there is always time and means to control the bleeding, at least temporarily. Many arteries that spurt freely when

first divided soon stop bleeding. Venous hemorrhage usually requires no treatment for it, and unless from large veins, ceases spontaneously.

Elevation of the part has a tendency to check arterial bleeding, and loosening of tight clothing or constricting surgical dressings will often cause venous oozing below the constriction to cease. In the first case the force of the arterial circulation is lessened; in the latter the impediment to the upward flow of blood is removed and the consequent distention of the veins prevented. Exposure of the bleeding surface to the air or the action of cold water or ice induces contraction of the vessels and diminution of hemorrhage. Laying open a bleeding cavity or removing the warm, poultice-like clots from a wound has a tendency to check loss of blood from small arteries and capillaries. Ice may be thrust into bleeding cavities, but its chilling and depressing influence must be watched.

Chemical agents with astringent properties are employed in surgery as blood-arresters, under the name of styptics, because of their tendency to promote contraction of the vessels and surrounding tissues, and because of their inducing rapid coagulation of the blood. The most common styptics are subsulphate of iron, perchloride of iron, alum, the salts of copper, zinc and silver, tannic acid, gallic acid, and various combinations of these with other ingredients. They are employed, either in powder or solution, upon a sponge or piece of cloth, which is applied to the bleeding surface. If the hemorrhage is from veins, capillaries, or small arteries, styptics may arrest it, but are needless because pressure by means of compresses or bandages is better.

If arteries of any importance are the source of bleeding, styptics are inefficient and, therefore, worthless. Hence, as they are either needless or inefficient, and are apt to be means of infecting the wound with bacteria, I regard styptics as useless agents for controlling such bleeding as is met in general surgery.

They are objectionable because practitioners resort to them and lose valuable time when ligation, torsion, or acupressure is required. Many of them, moreover, by irritating the surface and covering it with pasty clots, or by infecting it with pyogenic or putrefactive germs, prevent union by first intention. Hot water of about 120° F., locally applied, causes blanching of the surface and cessation of hemorrhage. It has the advantage over ice of not depressing the patient. All the methods thus far mentioned are greatly inferior to pressure and to occlusion of each individual vessel by ligation, torsion, or acupressure. These merit careful description, for they and the actual cautery are the only scientific and satisfactory modes of dealing with the hemorrhages usually observed by the surgeon.

When, as in deep cavities without bony walls, it is difficult or impossible to use ligatures or pressure, the cautery iron, heated only to a black or dull red color, may be employed to seal the vessels by converting the tissues into a dry eschar. Lidell advises in parenchymatous hemorrhage water of not less than 160° F. before resorting to cauterization. The water probably acts by coagulating the albumen.

Pressure is well adapted for temporarily arresting hemorrhage until ligation, amputation, or other operative measures can be performed. It is also of great value in the permanent arrest of bleeding in those cases when there is no vessel of sufficient importance to require ligation, torsion, or acupressure. In my opinion, pressure and ligation are the only hemostatic agents that the surgeon needs. Applied to the main artery in its continuity, pressure limits the flow of blood to the wound and thus checks

bleeding. This, which may be called arresting hemorrhage by indirect pressure, is generally accomplished by means of a tourniquet, or by pressure of the fingers. The pressure may also be obtained by using a conical bag of shot, or a pyramidal compress with a coin at its apex, or by placing a roll of cloth in the flexure of a joint and bandaging the joint in a strongly-flexed position. These methods are liable to do harm because they often interfere with the return circulation in the veins and thus induce congestion and œdema of the structures between the wound and the point where pressure is made upon the artery. They must be watched. Direct pressure upon the bleeding vessels in the wound is far better. An elastic bandage applied over a crushed and bleeding foot will stop all hemorrhage, and is far better than a tourniquet applied to the femoral artery, because, when reaction occurs and amputation is advisable, all the structures above the injury are in good condition and free from œdema.

A compress and an ordinary bandage, applied evenly and with moderate firmness, will arrest hemorrhage from capillaries, veins, and the smaller arteries. A bleeding cavity should be plugged with aseptic gauze or compressed sponge, which may, at times, be held in position with a bandage. No styptic is required, for the pressure causes approximation of the vascular walls, which is followed by internal coagulation, fibrinous exudation, and finally, by obliteration of the vessel. In wounds that are expected to heal by first intention the pressure is made upon the integument, after the parts have been properly adjusted. When healing by granulation is evidently the only method of repair possible, as is the case in wounds made in removing carious bone, the pressure is made upon the open vessels by filling the wound with gauze, and applying a retaining bandage.

In using pressure the surgeon must recollect that great force is not required, and that gangrene may result from tight bandaging. The oozing of blood-stained serum through the dressings must not be mistaken for a continuance of the hemorrhage. Enough gauze dressing should be applied to prevent the possibility of this serum reaching the surface, and becoming septic between the surgeon's visits. A considerable degree of pressure may be made with impunity if there is a voluminous gauze-dressing over the wound, because the elasticity of the dressing prevents the constriction from coming directly upon the tissues.

When bleeding from a wound is profuse, digital or instrumental pressure should be made upon the main artery, while the surgeon is tying or securing the vessels in the wound. The pressure can then at intervals be relaxed momentarily to allow the bleeding vessels to become distinguishable.

The *common carotid artery* is controlled by pressure made at the inner border of the sterno-mastoid muscle, on a level with the cricoid cartilage, and directly backward and inward against the cervical vertebræ.

The *subclavian artery* is controlled by pressure made above the clavicle at the outside of the sterno-mastoid muscle, and directly downward, and a little inward against the first rib.

The *axillary artery* is controlled by pressure made along the inner border of the biceps muscle and directed, through the upper part of the artery's course, outward against the shaft of the humerus.

The *femoral artery* is controlled by pressure made below the middle of Poupart's ligament, and directed upward and backward against the head of the femur and ramus of the pubic bone.

Occlusion by Ligation, Torsion, and Acupressure.—When hemorrhage comes from arteries, whose calibre equals or exceeds that of the facial, or from veins which are so situated that pressure cannot be well applied, each vessel must be separately treated. The methods employed to bring the walls of the artery or the vein into apposition, and thus close the lumen, are ligation, torsion, and acupressure. The best and most frequently used is ligation.

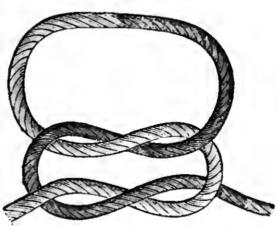
Ligation is simply tying a string tightly around the vascular tube, and thus completely closing its calibre. Ligatures are usually round cords of silk or catgut; though wire, tendon, and other materials are occasionally employed. Flat ligatures are, as a rule, not desirable. Catgut ligatures are best prepared by the method described for the preparation of antiseptic sutures in the chapter on Essentials of Practical Surgery. They should be kept stored in alcohol, and soaked in a beta-naphthol or sublimate solution before being used. Silk ligature must be made aseptic by boiling, or antiseptic by soaking in an antiseptic solution before use. A convenient length for a ligature is eight to ten inches, since such a cord can be readily drawn into a firm knot by the fingers.

When an artery is tightly tied with a ligature the external coat is deeply grooved by the constricting cord, while the middle and inner tunics are, on account of their brittleness, cleanly divided. The coats thus cut curl up more or less within the lumen of the artery, and aid the coagulation and fibrinous exudation which permanently seal the vessel. If the ligature is septic, or becomes so, the external coat of the vessel gradually ulcerates at the constricted point, so that, in the course of a few days or weeks, the noose of thread is found lying loose in the wound. Sometimes a little slough from the external coat is found in the noose when the ligature becomes detached. Aseptic or antiseptic catgut and similar absorbable ligatures become absorbed in a week or two, and do not cause ulceration of the outer tunic. Wire and silk ligatures, if not septic, may become encysted. Septic wounds are more liable to secondary hemorrhage than aseptic wounds, because of this possibility of ulceration and sloughing occurring in the vessels.

Veins have such pliable coats, that none, as a rule, are divided by the ligature, but all are simply corrugated at the point of constriction.

When a divided vessel in a wound is to be ligated the surgeon either seizes the bleeding end with a pair of catch forceps and draws it out from

Fig. 86.



Granny knot, which is never used in surgery. (J. D. Bryant.)

Fig. 87.

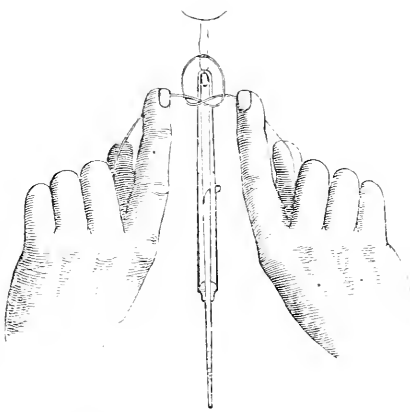
Flat or reef knot. (J. D. Bryant.)

the cellular and muscular tissue in which it is imbedded, or thrusts a sharp hook, called a tenaculum, into the wall of the vessel, or the tissue surrounding it. The vessel is then isolated from other structures, as much

as possible, and the ligature tied beyond the forceps or tenaculum, in a reef, or flat knot. (Figs. 86 and 87.) Care should be taken not to include any nerve in the ligature. The accompanying veins and the muscular tissue around an artery are usually separated from it before the ligature is applied; but in smaller arteries it does no harm to include these in the knot.

When the knot is tightened, the forefingers or thumb should be placed upon the string close to the artery and firm, steady traction made. (Fig. 88.) The amount of force required to tie even a large artery is not very great, and it should be done without jerking.

Fig. 88.



Manner of tightening ligatures.

The giving away of the inner and middle coats is often distinctly felt by the surgeon. Ligation, as a rule, merely corrugates the inner coats of the veins. Catgut ligatures should be given an additional third tie, because of the liability of the knot when made with catgut to become loosened; or they should be tied in the so-called friction or surgical knot. The ligature should have both ends cut off about one-tenth of an inch from the knot.

The method of applying ligatures to arteries in continuity, for the arrest of hemorrhage at a distant point and for the treatment of aneurism, will be described in the section which treats of the special ligations.

There are five rules to guide the surgeon in the use of ligation for arresting arterial hemorrhage:

I. In cases of *primary* hemorrhage do not ligate arteries which are not actually bleeding at the time, but have the patient carefully watched.

Reasons for this rule:

1. It is very possible that bleeding has permanently ceased.
2. It is difficult to be sure from which arteries the bleeding came.
3. All manipulations in wounds are to be avoided unless demanded.

Exceptions to this rule:

1. When a large vessel is plainly seen pulsating in the wound.
2. When the occurrence of even slight secondary hemorrhage would be disastrous; as in a very anæmic patient.
3. When, as in transportation, the patient will necessarily be away from surgical scrutiny.

II. In cases of *primary* and of *secondary* hemorrhage the ligature should be applied when practicable in the wound at the point where the artery bleeds, and not in the continuity of the vessel.

Reasons for this rule:

1. It is frequently impossible to know which artery is injured until the wound is opened.
2. Secondary hemorrhage may occur, even after ligation in continuity from the establishment of the collateral circulation. This secondary bleeding may come even from the proximal end of the cut vessel, if a branch of considerable size is given oft between the wound and the point of ligation.
3. Ligation in continuity makes a second wound, and adds the possible complication of this wound to the patient's original dangers.
4. Ligation in continuity remains, as a reverse step, still possible, if ligation in the wound fails.

Exceptions to this rule:

None.

III. If the artery is completely severed both ends should be tied; if it is partly divided or punctured, a ligature should be applied to the vessel on each side of such wound.

Reason for this rule:

The collateral circulation will probably cause secondary hemorrhage from the distal portion of the vessel, unless double ligation be adopted.

Exception to this rule:

When the distal end cannot be found, pressure must be made in its neighborhood.

IV. If a large artery is wounded near its origin, tie it below the wound, and tie the trunk, from which it arises, both above and below the point of origin of the branch. If a trunk is wounded near the origin of a large branch, tie the trunk with two ligatures in the ordinary manner, and apply a third ligature to the branch.

Reasons for this rule:

The force of a large current of blood near the internal coagulum may lead to its displacement, and cause secondary hemorrhage when the silk suture causes ulceration of the external coat, or the catgut or flat ligature is absorbed.

Exception to this rule:

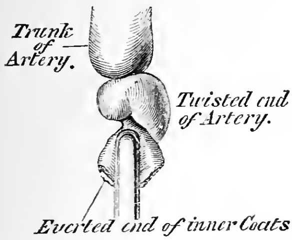
None.

V. When it is impossible or impracticable to tie the vessel in the wound, as in deep wounds of the pelvis, ligation in continuity may be permitted.

Torsion consists in occluding the cut end of the vessel by twisting it on its long axis. This is done by seizing the end of the cut artery with a pair of catch forceps, drawing it out of the sheath and giving it four or five sharp rotations. This twisting in the case of large arteries, like the femoral, should be repeated until the sense of resistance has ceased; but the end should not be twisted off. By this manœuvre the middle and inner coats are lacerated and curl up within the lumen of the artery, while the external tunic is twisted into a cord. This acts as a temporary plug until the internal coagulum and exudation of lymph are enabled to prevent hemorrhage and permanently close the orifice.

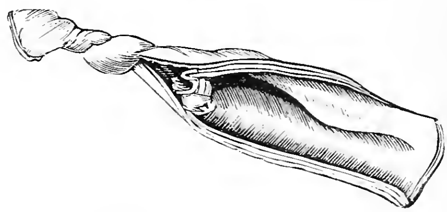
The twisted end is sometimes thrown off as a small slough; but if kept aseptic it becomes blended with the adjacent structures and is converted into fibrous tissue. In dealing with small arteries the ends may be twisted entirely off with impunity.

FIG. 89.



Torsion of an artery. (BRYANT.)

FIG. 90.



Effects of torsion on arterial coats.

Some operators perform limited torsion instead of the free torsion just described. Limited torsion is performed by drawing the vessel out and grasping it transversely a little above the end with a second pair of forceps. When rotation is then made by means of the first forceps the effect of the twisting cannot extend above the point held by the second pair. This method is convenient when the artery is loosely connected with surrounding parts.

The chief advantage claimed for torsion is that it leaves no foreign material in the wound as does the ordinary ligature.

Aseptic catgut or silk ligatures being either absorbed or encysted do not act as foregin bodies, but allow the wound to be at once closed. It is, therefore, in this respect comparable to torsion; hence, as ligation is much safer than torsion, I greatly prefer ligation to any form of twisting, except for vessels of inconsiderable size. When the hemostatic forceps, used to arrest hemorrhage from cut vessels during the continuance of an operation are to be removed, a few preliminary twists given to the vessels will often avert the necessity of ligature.

ACUPRESSURE.—Hemorrhage from a divided vessel may be arrested by introducing a long needle or pin into the surrounding tissues in such a manner as to compress the artery or vein. This compression, called acupressure, may be increased by adjusting a wire or thread around the ends of the pin as in the harelip suture, or by twisting the tissues and the artery during the insertion of the pin. The pins, which must be aseptic, must not be permitted to remain in the tissues longer, at the furthest, than three days. Usually they should be removed in twenty-four or forty-eight hours. The time depends upon the size of the artery. Large arteries require longer pressure than small ones, to insure against secondary hemorrhage. Herein lies the chief objection to acupressure. If the pins are removed too soon, secondary hemorrhage may supervene; if they are allowed to remain too long, they may cause irritation or interfere with the dressings, and there is nothing gained over the use of the ordinary ligature. Acupressure is a valuable means of arresting bleeding when the surgeon has no assistants and is in a hurry. It stops the hemorrhage until better methods can be applied. It is also useful as a preliminary to operations which must of necessity divide definite vessels. Thus the facial artery can be compressed before cutting into the cheek. So also the tissues around

vascular tumors can be thus compressed by pins with threads wrapped around the ends before their excision is begun.

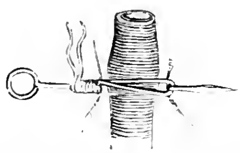
Acupressure acts as a hemostatic by bringing the vascular walls together and thus shutting out the blood current until repair goes on by exudation of lymph at the cut extremity of the vessel. An internal coagulum forms above the point of acupressure, but does not seem to play any part in the function of the permanent repair. Permanent closure is effected entirely below the constriction caused by the pin in the same manner as in nature's method of arresting bleeding and repairing cut arteries. If the pin remains long enough to destroy the structure of the inner coat, the same changes occur as after ligation.

Acupressure pins are removed by seizing the head and gently rotating and withdrawing the pin from the tissues while the parts are supported with the other hand of the surgeon.

Of the many methods of obtaining pressure upon an artery by means of a needle or pin thrust into the tissues there are only four that deserve special attention and description:

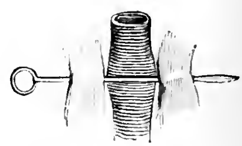
1. The point of the pin is introduced through the skin perpendicular to the course of the vessel, the free end of the pin is depressed, the point is then carried across behind artery until it emerges from the skin at the

Fig. 91.



First method of acupressure. (Bryant)

Fig. 92.



Second method of acupressure. (Bryant.)

opposite side of the vessel. The elastic skin exerts sufficient tension upon the pin to cause approximation of the arterial walls. If complete constriction is not thus induced a silk or catgut thread may be wrapped around the exposed ends of the pin, as is done in the pin or harelip suture. This reinforcement of pressure may become especially necessary when pins are introduced from raw surfaces, in which the elasticity of the skin does not exist.

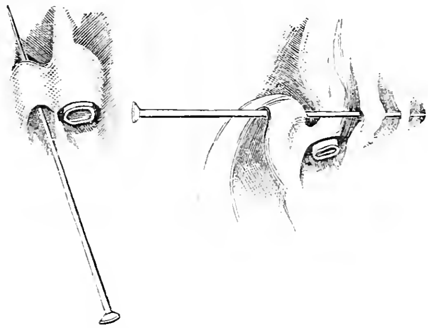
2. The pin is thrust through a thick fold of muscular tissue at one side of the vessel, carried across the front of the artery and thrust through a second thick fold of the tissue at the other side. The pin is thus pressed back upon the artery by the tension of the transfixed muscular masses. This method obliterates the calibre of the vessel best when firm structures, such as bone, fascia, or skin, lie behind the artery and furnish counterpressure.

3. The pin is introduced parallel to the axis of the artery through a fold of tissue near one side of the vessel; the free extremity of the pin is rotated in the horizontal plane through one-quarter of a circle, and the point is then carried across the front of the artery and fixed by being deeply buried in the soft structures on the other side. The artery is thus closed by the twisting of its coats and of the surrounding tissues.

4. The pin is inserted at right angles to the axis of the artery through a fold of tissue; the point is then carried across the front of the artery, and the free extremity of the pin rotated in the vertical plane through a half circle and the point fixed by being deeply buried in the soft struc-

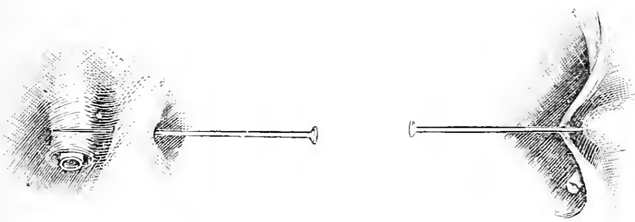
tures behind the vessel. Occlusion is accomplished somewhat as in the previous method by the twisting induced by the rotation of the pin.

Fig. 93.



Third method of acupressure.

Fig. 94.



Fourth method of acupressure.

Acupressure is, in my opinion, far inferior to ligation, which method, when aseptic catgut or silk ligatures are employed, secures the greatest safety and has no tendency to retard primary union.

When it is difficult to apply ligatures or acupressure in deep wounds, the hemostatic forceps may be used to seize and close the arterial wound and then be allowed to remain so attached as clamps for one or two days. If aseptic they do no harm, except to make dressing of the wound a little inconvenient.

Treatment of Secondary Hemorrhage.—The prevention of secondary hemorrhage is to be secured by obtaining rapid union in wounds. Hence, absence of pus is a primary factor. Consequently antisepsis and provision for free drainage are absolutely demanded.

When secondary bleeding is feared the patient should be kept absolutely quiet, and undue circulatory activity controlled by aconite, low diet, laxatives, and possibly venesection. Morphia and ergot given internally in full doses are beneficial from this point of view. So also is partial compression of the main arterial trunk supplying the injured region, and elevation of the limb in which bleeding is feared.

In dealing with secondary hemorrhage the surgeon must not delay. In primary hemorrhage it is injudicious to take active steps when bleeding has already ceased, unless the circumstances are exceptional. The case is different in secondary bleeding. The first escape of blood, even in small

quantity, calls for action, which may, it is true, be limited to elevation of the part and compression of the wound and main artery by compresses and bandages; but the second actual outbreak of hemorrhage imperatively calls for prompt surgical measures. If healing of the wound is still quite incomplete the sutures should be withdrawn, the clots turned out, and the vessel from which bleeding has come securely ligated. As it may be somewhat difficult to determine the exact source, every suspicious point should be ligated. If the softened or sloughy condition of the wound surfaces prevents satisfactory application of ligatures, the actual cautery may, perhaps, be available.

Opening the wound is the proper procedure even if union is well advanced, for the escaping blood has usually distended the wound cavity before the existence of bleeding has been detected, and by this action, moreover, the surgeon obtains the most accurate information possible of the character of the complication with which he has to deal. Acupressure applied by the first method described on page 236, is often a valuable means of arresting the bleeding either before or after the wound is reopened. By thrusting the pin deeply through the tissues and reinforcing the pressure with a strong thread wrapped around the ends, the surgeon is enabled to compress parts in which one or more bleeding arteries are situated. This manœuvre may be employed to avert the necessity of laying open the partially cicatrized wound, or to secure vessels whose patulous mouths cannot be found on the surface of the wound because of spontaneous cessation of bleeding.

Instead of an acupressure pin a strong ligature may be carried through the tissues by means of a long needle; by tying the ends of this cord together constriction may be effected that will restrain hemorrhage, though not sufficiently great to cause strangulation and gangrene.

The elastic bandage applied with only moderate firmness over the wound at times proves a valuable aid in resisting secondary bleeding.

When secondary hemorrhage persists despite the direct treatment applied at the seat of trouble, it is proper to ligate the main artery in continuity, as is done in dealing with aneurisms. Such ligation should be performed as near the seat of hemorrhage as possible unless the anatomical relations of the regions make it known that the arterial anastomosis will soon establish such a collateral circulation that hemorrhage will probably recur in the original locality. Then it becomes necessary to select a higher point for the deligation. In secondary hemorrhage of the palm, for example, it is usually better surgery to ligate the brachial artery than to tie at the wrist the radial or ulnar or both; this is a fact because the anastomosis between the arteries of the forearm is so free.

Secondary hemorrhage may supervene after an arterial trunk has been tied in its continuity for the cure of aneurism or the arrest of hemorrhage at a lower point. Here the first step is to apply pressure to the seat of ligation by a graduating compress, or by plugging the wound. If this fails the wound must be opened and a ligature applied at each side of the orifice in the vessel, which must then be completely divided between the ligatures, if the original injury did not do so, in order to allow retraction and contraction of its walls. In the event of this being followed by recurrence of hemorrhage, either a second deligation in continuity at a higher point, with or without contemporaneous ligation of one or more anastomosing branches, or amputation of the limb must be performed.

Gangrene is apt to occur when a second ligation is done in the lower extremity, because the collateral circulation is rarely sufficient to main-

tain the vitality of the distant parts. Hence, some high authorities have recommended amputation rather than second ligations for persistent secondary hemorrhages under such circumstances.

When the original source of secondary hemorrhage is a vessel near the aorta, pressure at the seat of bleeding is the only resource. Indeed, pressure, judiciously applied by pads, plugging, and shotbags, has at times been efficacious when ligation above the seat of hemorrhage has failed. This is due to the circumstance that the escape of blood comes very frequently from the distal portion of the injured vessel, to which the anastomosing branches have given an abundant blood-current.

Wounds of Veins.

The discussion of hemorrhage has involved some consideration of wounds of veins, but a few points remain that deserve more extended attention. The dangers from wounded veins are hemorrhage, septicæmia, diffuse phlebitis, and entrance of air into the heart.

The bleeding from large venous trunks is as fatal as arterial hemorrhage, but that from small veins usually stops spontaneously unless there is some source of constriction upon the cardiac side of the wound. Good examples of this are seen in the constricting bandage placed above the elbow in cases of venesection, in order to obtain a prolonged and free flow of blood from the wounded vein; and in protruding hemorrhoidal tumors pinched by the sphincter of the anus, which will continue to bleed until the anus is dilated by the fingers or the tumors replaced within the rectum. Blood flows from wounded veins in a dark, rapid stream without showing the pulsatile action of the heart; it has, however, an increase in its force during each act of expiration, if the seat of hemorrhage is near the trunk. Pressure made on the cardiac side of the wound causes an increased flow of blood. This may be of diagnostic value in deep wounds, for blood from arteries may be dark during anæsthesia, or when the bleeding comes from the distal end of a divided artery in one of the extremities.

Subcutaneous rupture of a vein from violence may occur. The extravasation of blood, even if large, is usually absorbed in a few days or weeks; but it may cause inflammation leading to abscess, if pyogenic bacteria gain access to it, or become encysted in a fluid state, giving rise to the fluctuating tumor called hematoma. Contusions of veins, as of arteries, may be unaccompanied by symptoms of special import until secondary hemorrhage occurs from the ulceration or sloughing of the injured vessel wall.

When veins are completely divided slight contraction and retraction of the coats occur, but not in a sufficient degree to restrain hemorrhage from the larger vessels.

Incision and puncture of veins, when not fatal, usually heal rapidly and perfectly by first intention, leaving no scar and not encroaching on the calibre of the vessel. Such is not the case in arterial wounds which are followed by obstruction of the vessel at the seat of puncture. This is well illustrated by the wound of the median basilic vein made in venesection. Small wounds of varicose veins or of the larger trunks may prove fatal from anæmia, if the bleeding is not arrested by pressure or ligation. Injurious secondary results may follow when the blood is poured into the cavity of the cranium, thorax, or abdomen. Often this

is the chief danger. Wounds, even of the large cerebral sinuses, are not of very grave prognosis, if the blood is given full opportunity to escape, for moderate pressure arrests the hemorrhage in these venous channels of slow current.

Wounds of small or moderate size veins require little special treatment. Elevation of the part, removal of all constriction of clothing on the cardiac side of the injury, and slight pressure by a compress and bandage are sufficient. In three or four days cicatrization occurs. Large veins require ligation. Styptics should never be employed. A catgut ligature should be applied below and another above the wound, if the vein is not completely divided; or the wound may be closed by fine catgut sutures. Either of these is perhaps a better safeguard against secondary hemorrhage than lateral ligation. By lateral ligation is meant tying the portion of the wall of the vein immediately surrounding the wound. This is readily done in large veins by grasping the flaccid coats of the vessel with forceps and tenaculum and tying the ligature around the tissue so seized. Such a ligature is possibly liable to slip off; hence suture may in some instances, at least, be better. Lateral ligature and suture do not entirely destroy the continuity of the vessel as does circular ligation above and below the wound. Aseptic ligation of veins is not apt to produce diffuse phlebitis and pyæmia, as was formerly taught. The method of repair after ligation of veins is similar to that which obtains in arterial ligation. The ligature does not, however, cut the internal and middle coats of the vein, but merely corrugates them; or, at most, divides only the inner layer of the middle tunic. Coagulation then occurs at the distal side of the ligature, and inflammatory changes ensue which permanently seal the vessel. In some cases the bleeding may be satisfactorily controlled by seizing the wounded portion with hemostatic forceps, so placed as to close the opening and leaving them hanging in position for twenty-four or forty-eight hours.

Septicæmia may follow venous wounds, if the open vein or sinus is surrounded by unhealthy pus; hence absence of putrefaction and provision for drainage are important features in treating wounds in which large veins are opened. Ligation by closing the open orifices tends to prevent such septic infection, and is, therefore, at times advisable in major operations, when sepsis cannot be prevented, even when there is no liability to venous hemorrhage.

When the large veins of the extremities, such as the femoral or axillary, are wounded, ligation of the accompanying artery also may, according to some authorities, be proper and judicious after ligation of the vein. The flow of blood to the limb is thus diminished; venous congestion of the tissues is thereby prevented, because the equilibrium in the capillaries is less disturbed; and the possibility of gangrene is probably less. Further evidence of the advisability of such simultaneous ligation of veins and arteries is desirable. I very much doubt its propriety in the upper extremity, though willing to admit its probable value in wounds of the femoral vein.

Trephining may be required after wounds of the sinuses of the dura mater to allow the removal of clots causing compression of the brain. Moderate pressure upon the injured venous channel with antiseptic cotton will control hemorrhage. Hemostatic preparations of iron or other styptics should not be employed.

If from any cause the wound in a vein is kept widely open during violent inspiratory efforts, air may be sucked into the venous circulation

and be carried to the right heart. This dangerous accident is especially liable to occur during operations in the vicinity of the internal jugular, subclavian, innominate, and axillary veins; though it has been stated that it may happen in veins of smaller calibre and in those situated further from the heart. The manner in which wounded veins ordinarily become collapsed during inspiration usually prevents the entrance of air; hence it is only when some cause holds the lips of the wound apart that sucking air into the veins is possible. This may be due to inflammatory thickening of the walls converting the vein into a tube, the so-called canalization of the veins; to the vessel being imbedded in hardened tissue or in the substance of tumors, which prevents collapse; or to the efforts of the surgeon who, in attempting to enucleate a tumor or foreign body, pulls the walls of the vein apart at the time of a deep inspiration. The accident is less common since the introduction of anæsthesia, because there are less struggling and gasping on the part of the patient, and more deliberation exercised by the surgeon. It is possible, however, that some of the deaths attributed to anæsthesia may be cases of air in the veins.

The symptoms of entrance of air into the veins are marked. During the progress of an operation a sudden sucking sound is heard; frothy blood is, perhaps, observed in the wound, the pulse fails, the heart beats irregularly and feebly, respiration is oppressed, and syncope or, perhaps, convulsions occur. If the amount of air drawn in is small, recovery gradually takes place; if the quantity is considerable, coma and death supervene. The fatal issue may be immediate, but usually is postponed for a period varying from a few minutes to an hour. In cases that recover transitory paresis has been observed. Secondary pneumonia has proved fatal in others.

Occasionally a sound similar to that produced by air entering the veins occurs when the deep fascia of the neck is incised. I was once startled by this phenomenon when performing tracheotomy for great dyspnœa in diphtheria.

The pathology of the symptoms induced by air in the veins is not understood. It is probable that the air, causing a frothy condition of the blood in the right auricle and ventricle, prevents proper action of the valves and interferes with the blood transfer in the pulmonary circulation. Anæmia of the brain and other nerve centres is thus induced.[1]

This serious complication of operative surgery, which must be quite rare, is to be prevented by securing regular and quiet respiration during anæsthesia, by tearing the tissues in the vicinity of large veins apart with fingers and dull instruments, instead of using the knife, and by avoiding any posture of traction that tends to keep venous wounds gaping. When it becomes necessary to divide a large vein the surgeon should make pressure with the fingers upon the vessel at the cardiac side of the proposed wound. This should be done also when firmly attached tumors are being forcibly enucleated. It has been proposed to bandage the chest as a preliminary measure before operating in the region made dangerous by the situation of the large venous trunks. Thus unexpected deep inspiration is prevented.

When air has actually been sucked into the veins, prompt treatment is demanded. The vein should immediately be compressed at the cardiac side of the wound, and ligatures should then be applied on both sides of

[1] See N. Lewis's paper, Amer. Surg. Assn., 1885.

the orifice. The patient's head should be lowered, stimulants should be given, and artificial respiration instituted.

Galvanism of the chest and cardiac region, transfusion of blood or of warm water, tracheotomy, venesection, and pumping the air from the veins or even from the heart by the aspirator, have been proposed. The injection of warm water directly into the heart-cavity has been suggested. If the symptoms depend upon failure of the valve action because of absence of fluid in the heart, this may perhaps be a rational therapeutic measure.

It is probable that the dangers of air in the veins and heart have been overestimated.

Diseases of the Veins.

Inflammation of Veins, or Phlebitis.

Varieties.—Inflammation of veins may be plastic or suppurative.

Idiopathic phlebitis is quite rare, but occasionally occurs in the course of fevers, or as the consequence of syphilis, gout, varicose veins, and possibly of exposure to cold. This form of venous inflammation is more apt to be located in the veins of the lower extremity than elsewhere, and does not often assume the dangerous characteristics that quite frequently belong to traumatic phlebitis, because traumatic phlebitis is often septic. Traumatic inflammation follows contusion, rupture, or incision of the venous walls, and may also be due to violent muscular contraction and pressure. Uterine phlebitis after parturition is a phlebitis possibly due to the cause last mentioned, but probably a result of microbic infection. Inflammation of the tissues around a vein may cause phlebitis, which should then be considered a form of traumatic phlebitis secondary to peri-phlebitis. Traumatic inflammation of veins in healthy subjects is usually a localized affection of slight gravity. If, however, septic changes occur in the wound, especially it would seem when the orifices of the divided veins remain open, a diffuse or suppurative phlebitis, allied to pyæmia, and of a most dangerous character may arise. Operation wounds of veins are usually of slight gravity, because the consequent phlebitis is an uncomplicated and localized adhesive inflammation.

Pathology.—Coagulation of blood in the living veins, technically called thrombosis, is always an accompaniment of phlebitis. This clotting may be the cause of the inflammation. Such is the case at times in the phlebitis secondary to varicose veins. Here the overstretched venous walls, with imperfectly-acting valves, allow retardation of blood-current, and the consequent thrombosis sets up inflammation of the vascular tunics. On the other hand, thrombosis may be the result of inflammation, as is probably the case in traumatic phlebitis.

The pathological changes of phlebitis occur principally in the outer and middle coats, which in veins, indeed, are scarcely to be considered as two distinct tunics. Hyperæmia of these coats and infiltration of the spaces between their vessels with cells and serum are observed. These changes necessarily induce swelling, thickening and loss of flexibility of the walls, which may remain patulous when divided. The internal coat becomes cloudy, fissured and shreddy, and may be separated from its neighboring tunic by the disintegrating influences of inflammation. At the seat of inflammation coagulation takes place within the vein at an early stage of the phlebitis. If the clot is aseptic and remains so, the

inflammatory process is localized. The vein may then be converted into an impervous fibrocellular cord, as occurs after arterial ligation. If the coagulum adheres to only one side of the vein, however, partial circulation may finally be established through the vessel; or, if complete removal of the clot by absorption occurs, the calibre of the vein may be perfectly restored.

The occurrence of suppurative and gangrenous inflammation of veins leads to disintegration or yellow softening of the clot, and the dangerous septic elements are admitted into the general circulation.

As a result, portions of the coagulum are worked loose and carried to the right heart and thence into distant arteries. Such plugs or emboli produce infarctions and abscesses; and because of an infective nature lead to pyæmic symptoms and death. It is for this reason that phlebitis in broken-down subjects or in those suffering from infected wounds, is regarded as a disease of grave prognosis.

Symptoms.—Inflammation of a subcutaneous vein gives rise in the course of the vessel to a hard painful cord, which is accompanied by some swelling and a distinct dusky-red or copper color line upon the overlying skin. The cord often has a knotted appearance indicating the situation of the valves of the diseased vein. Coagulation in the vessel impedes venous return from the distal part of the limb and causes œdema, which may be further increased by actual inflammation of the general connective tissue of the extremity. In the latter event, there is more induration than in simple œdema from circulatory obstruction. Stiffness of the limb affected with phlebitis and pain, often of a character resembling neuralgia, are present. Phlebitis, when not localized, usully extends in the direction of the heart.

When the deep veins only are inflamed the vessels are not mapped out by the subcutaneous rigid cords that serve to distinguish superficial phlebitis, neither are the copperish lines seen; but the painful stiffness and œdema are perhaps the only indications of inflammation. The diagnosis, consequently, is sometimes difficult.

The constitutional symptoms are slight in localized venous inflammation; but when the disease is more extensive, febrile movement is present. In the event of septic infection occurring in the manner explained in the paragraph on the Pathology of Phlebitis, chills, sweats, high temperature, a rapid thready pulse, and delirium are to be expected. Under such circumstances embolic abscesses and death from pyæmic symptoms may readily supervene. Embolic abscess of the liver may thus occur in portal phlebitis. A close connection exists between rapidly-spreading phlebitis, with its ulceration and gangrene of venous walls, and diffuse cellulitis and erysipelas. They all tend to destroy life by the induction of septicæmic processes; and are due to mycotic infection. Non-septic phlebitis is, even when extensive, of favorable prognosis. Septic phlebitis is a very fatal disease.

Phlebitis is to be distinguished from inflammation of the lymphatic vessels, or angeioleucitis, by the absence of glandular involvement and by the darker red of the cutaneous line indicating the course of the affected vessels. Neuralgia and neuritis are unaccompanied by the œdema which almost invariably attends phlebitis.

Treatment.—Phlebitis is to be treated by absolute rest of the part affected, and by the avoidance of all causes that might favor the separation or disintegration of the intravascular coagulum. Pyogenic and putrefactive infection must be rigidly averted. Slight elevation of the

limbs to favor the return circulation is judicious and lessens pain. Leeching, lead-water and laudanum, mercurial ointment, evaporating lotions, fomentations of various kinds, and tincture of iodine have been found useful as local measures. Quinine, iron, and rest in bed are essential in cases of even moderate severity. Cardiac depressants are to be avoided because of the possibility that septicæmia may arise from unexpected infection.

When inflammation is spreading rapidly up the vein, Mr. Lee suggests compressing the vein at two points—above the seat of inflammation by acupressure pins, and subcutaneously dividing the vessel between them.

If suppuration, great œdema, and diffuse cellular inflammation arise, free incisions, parallel to the veins, should be made.

This procedure should be followed by thorough antiseptic irrigation and drainage.

To remove the swelling and hasten the absorption of inflammatory deposits, due to phlebitis of a chronic type, elevation, friction, massage, and pressure by the elastic bandage should be employed.

Hypertrophy and Varicosity of Veins.

Definition.—When an abnormal quantity of blood is constantly carried by a vein, the vessel becomes enlarged in calibre and thickened in its coats. This constitutes hypertrophy of veins; and is seen, for example, when obstruction of a vena cava causes enlargement of the external epigastric vein and the veins of the anterior walls of the chest, and in other instances of unusual development of the collateral venous circulation. No treatment is required, for the condition is a compensatory one. When the amount of blood in a vein is diminished, as happens after amputations, venous atrophy results.

Varicose veins are veins which, on account of disease of the walls, have become enlarged and more or less irregularly dilated and thinned, and in which the blood current is abnormally retarded. Varix, or varicose vein, is, therefore a condition that should be distinguished from hypertrophy of veins.

Pathology.—Varicosity is most frequently met with in the veins of the leg, spermatic cord and rectum; though the condition may arise in any location, even, it is stated, in the veins of osseous tissue. The long saphenous vein is very frequently affected. The condition is probably due to a paresis of the muscular tissue of the vessel wall depending upon degeneration of muscular fibre or imperfect innervation. Any impediment of the blood current acts as a predisposing cause of varicose veins by increasing the intravenous hydrostatic pressure. Hence gravity has long been regarded as a prominent factor in the production of varix. I doubt whether such causes are capable of giving rise to varicosity, when collateral venous circulation is possible, unless at the same time there be some degenerative process going on in the venous walls. I should as soon expect to see aneurismal dilatation of an artery produced by simple interference with the blood current without previous disease of the arterial tunics. If the flow of blood is arrested in an artery the anastomosing arteries become hypertrophied; so is it in the case of veins. If the blood current is impeded in one vein, the collateral circulation is established and the adjacent veins become hypertrophic.

Heredity, debility, continued standing, the wearing of tight garters, and

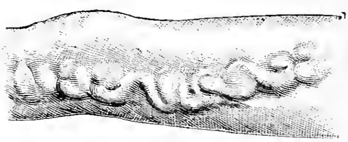
many other factors have been accused as causes of varicose veins; but there must be some as yet unknown influence that determines the occurrence of this pathological venous lesion.

The pathological changes found in varix are dilatation, increased length and tortuosity, hyperplasia of connective and other tissues, causing irregular thickening of the venous walls, incompetent valves due to partial destruction of the leaflets, or to the impossibility of contact resulting from the increased calibre of the vessel, and sacculation similar in appearance to the pouched condition of the colon. The irregular dilatations, causing sacculation, are especially prominent at points where two veins unite.

The wall in such pouches is exceedingly attenuated. Chronic inflammatory changes are apt to arise in the tissues surrounding varicose veins, causing œdema, obstinate ulcers and even a condition resembling Arabian elephantiasis.

Coagulation may occur within varicose veins, and thus induce inflammation or occlusion and partial cure. Suppuration may occur from infection with pus germs. Calcareous degeneration of the clot sometimes takes place, and concretions, called vein-stones, or phleboliths, remain. These may be either free or adherent to the wall of the vein. They are also, however, found in veins not varicose, and are especially liable to occur in the veins of the pelvis. It is believed that these pelvic phleboliths may also be formed outside of the vessel and subsequently penetrate the venous walls.

Fig. 95.



Varicose vein. (Bryant.)

Symptoms.—The symptoms of varix are, dull pain, a sensation of weight or fulness, numbness, and perhaps some impairment of power. Inspection shows a characteristic, bluish, knotted, soft tumor, in which the dilated and tortuous veins can readily be recognized. Œdema, induration, eczema, and chronic ulceration of the skin are frequently present in varix of the leg of long standing. It is probable that the deep veins are affected about as frequently as the subcutaneous, but when the affection pertains only to the former the diagnosis is difficult. Gay thinks muscular cramps indicative of deep varix. Slight local varicosities of the cutaneous capillary veins are quite common in women, giving rise to an arborescent appearance of the skin without swelling or other symptom.

Profuse bleeding may supervene from perforation of a varix by ulceration. It is improper to say that the varicose vein bursts, since the ulcerative process begins externally. The copious hemorrhage probably comes from the cardiac portion of the vein, which is distended with blood and furnished with diseased valves incompetent to resist the backward current. Moderate pressure with a finger or compress will control the bleeding, which, if not arrested, may prove fatal.

Phlebitis, with its characteristic thrombosis, may be developed in varicose veins without any specially assignable cause.

Treatment.—The distress produced by the existence of varicose veins can be greatly palliated by such artificial support as is obtained by covering the limb with elastic webbing, or a rubber bandage, applied smoothly and with very moderate pressure. To prevent cutaneous irritation from retention of secretion it may be necessary to cover the skin with a soft piece of cotton or linen cloth, before applying the rubber bandage. If

ulceration exists, ointments or solutions can be thus applied before the bandage is adjusted. A silicate of sodium case, such as is used in treating partially united fractures, makes a convenient support for varicose veins of the leg. These appliances for pressure should be removed at night only after the patient has assumed the recumbent posture.

Elevation of the leg while keeping the patient in bed and pressure of this sort will greatly hasten the cure of eczema and ulcers complicating varicose veins of the lower limbs.

The radical treatment of varicose veins depends upon occlusion of the calibre of the vessel; or, in other words, upon obliterating the vein at the point operated upon, and thus compelling anastomosing veins to carry on the circulation. The symptoms of varix are removed at the points of operation, and much relief may thus be afforded the patient; but the condition persists, or is soon developed in the adjacent veins, either superficial or deep. There is a risk, though an exceedingly slight one, of inducing dangerous phlebitis by these operations, for the so-called radical treatment of varix. Such measures are to be recommended when inconvenience, pain, intractable ulceration, or the danger of hemorrhage from perforation renders the patient uncomfortable. Antiseptic surgery renders these operations trivial.

The most approved methods are the subcutaneous ligature and acupressure. Subcutaneous ligation is effected by carrying a catgut ligature beneath the dilated vein by means of a straight needle, which is then reëntered at the point of exit and thrust in front of the vein until it emerges at the first puncture. Withdrawal of the needle through this original opening causes the vein to be subcutaneously encircled by a loop of catgut.

FIG. 96.

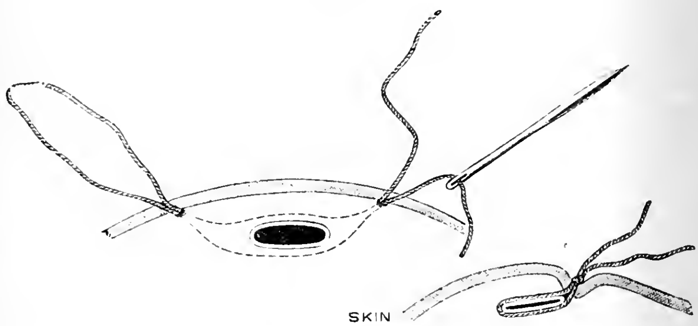


Diagram of subcutaneous ligation of varicose veins.

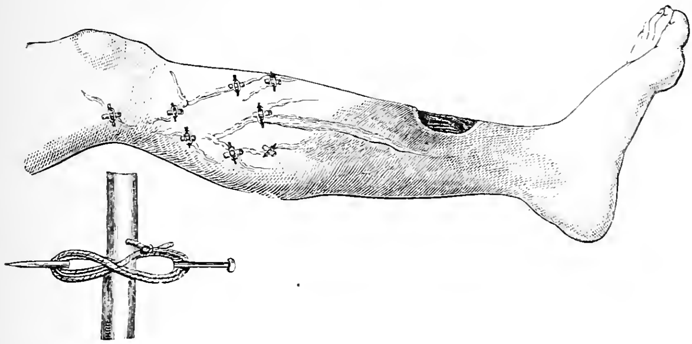
The ligature is then drawn tightly around the vein and the ends tied. The coats of the vein are thus brought into apposition and internal coagulation, with consequent local plastic inflammation and occlusion, results at as many points as the surgeon has ligated. The catgut ligatures become absorbed and need no attention. The veins should be ligated at numerous points, and care must be taken to avoid transfixing the vessel with the needle. It is well to insert the ligature nearest the heart first and to have the limb dependent, so that the vein may be distended to its fullest capacity.

Acupressure acts in a similar manner. Harelip pins are thrust behind

the varicose veins at various points about one inch apart, and the compression obtained by a figure-of-eight or elliptical ligature applied as in making the twisted suture. The uppermost pins should be inserted first.

The pressure may be increased by laying small pieces of rubber upon the skin at right angles to the pins and tying the ligatures over these.

Fig. 97.



Varicose veins treated by acupressure. (Erichsen.)

The pins should be withdrawn after the lapse of eight or ten days. A modification of this method is to compress the vein with pins and then subcutaneously divide the vessel by means of a tenotome. The pins are removed in about four days. Obliteration of the vein is thus insured, and there is little danger of septic phlebitis. It is a good method. Excision of about two inches of the vein through an ordinary cutaneous incision is a successful method. It must be done aseptically. After any of these methods of operating a bandage should be applied to the limb and the patient kept in bed. Elastic stockings or rubber bandages should be worn after the patient assumes the erect posture.

Intravenous injection of coagulating fluids, such as the iron salts, tannin and chloral, peri-vascular injections of ergotine, the application of caustic issues over the varix, and excision of portions of the dilated vein have been advocated. I reject them as probably more dangerous than subcutaneous ligation or acupressure.

Patients with varicose veins, if debilitated, should be treated with tonics and made to refrain from occupations that require standing or other positions favoring venous stasis.

Fluid extract of hamamelis has recently been recommended as an internal remedy to be administered in fluidrachm doses several times daily. Its value, if it has any, is due to its astringent action. If hemorrhage occurs from varix, elevation and a moderate compress will stop it.

Varicocele and internal hemorrhoids are instances of varix in special localities, which will be discussed in subsequent chapters.

Diseases of Lymphatics.

Wounds of Lymphatics.

The lymphatic vessels of the body, which in their universal distribution exceed in number the bloodvessels, are injured in all wounds. Lymph

escapes from the several vessels, but is mixed with blood, and demands no especial notice. It is only when the thoracic duct, a large lymphatic trunk, or a varicose lymphatic vessel is wounded that the escape of lymph is dignified by the name lymphorrhagia. The fluid thus discharged is at times transparent, at others milky in appearance, and may continue indefinitely if a fistula becomes established at the seat of injury. When a lymphatic vessel becomes occluded from pressure of a tumor or from disease, collateral lymphatic circulation is established, just as happens in veins. The lymphatic vessels and their valves much resemble veins as well in function as in histology. Lymphorrhagia is to be treated by pressure applied to the distal portion of the vessel, and lymphatic fistulas by compression and cauterization. Incision of lymphatic glands is said to have been followed by lymphatic fistulas.

Inflammation of Lymphatic Vessels or Lymphangitis.

PATHOLOGY.—Lymphangitis, or angeioleucitis, may be idiopathic, but generally it is traumatic. It should be remembered that though traumatic in origin, it may first appear at a distance from the wound. It is especially liable to follow injuries inoculated with septic or other micro organisms. Simple lymphangitis is much less dangerous than the septic form, which frequently has a fatal issue.

The pathological changes are similar to those found in phlebitis. The lymph loses its transparency, becomes opaque, and forms thrombi or clots of a pinkish color in the vicinity of the valves. These clots, by adhering to the vessel wall may cause occlusion, or they may break down into pus. Thickening, opacity, and dilatation of the walls of the lymphatic vessels occur and the internal tunic becomes uneven. If occlusion is produced the ducts anastomosing with the obliterated vessel soon become distended and carry on the circulation of lymph. The connective tissue about the inflamed absorbents becomes infiltrated with lymph cells escaping from the vessels and peripheral œdema is induced by obstruction of the lymph current due to the internal thrombosis.

The infiltrated structures may be relieved of this inundation by absorptive processes, may suppurate, or may become indurated and hypertrophied. It is probable that occlusion of lymphatic vessels from repeated lymphangitis occurring in connection with cutaneous changes, is a factor in the causation of certain cases of Arabian elephantiasis. Cellulitis and arthritis may be secondary to lymphangitis, and even go on to suppuration.

SYMPTOMS.—Inflammation of the fine capillary absorbent vessels, which form an anastomosing network, is called reticular lymphangitis, while inflammation of the larger ducts is termed tubular lymphangitis. Reticular lymphangitis occurs in patches, and may or may not be associated with inflammation of neighboring ducts of larger calibre. The adjacent glands, however, are nearly always involved. The patches are hot, red, painful, and surrounded by slight œdema, and may go on to suppuration. Slight wounds, such as needle pricks, at the end of the finger, especially when infected with pathogenic bacteria and when in debilitated subjects; and frequent contact with septic tissues, even without breach of surface, may give rise to reticular absorbent inflammation, which may be manifested by multiple spots of inflammation successively extending up the limb. Certain forms of felon are instances of lymphangitis, and the skin

disease called erythema nodosum is believed by some authorities to be a reticular lymphangitis, with lymphatic œdema.

Tubular lymphangitis, when affecting the superficial vessels, is manifested by the appearance of vivid red cutaneous lines running from the primary lesion toward the heart. These lines mark the centre of the inflamed ducts which, by palpation, can be felt as hard threads. There may be only slight tenderness along these red streaks, which by coalescing make bands nearly an inch wide, but usually pain is marked and swelling of the limb observable. The nearest lymphatic glands soon become swollen and painful. Subsequently a second group of more distant glands may be similarly involved, though there need not be any marked evidence of inflammation of the lymphatic vessels connecting the two glandular swellings. Resolution may occur in a week or ten days, though suppurative inflammation of the glands or of the vessels is not unusual. Glandular implication is almost never absent in lymphangitis. It is stated, however, that in septic inflammation of the lymphatics such involvement may at times be wanting even when the synovial lymphatic structures show suppurative processes of great severity. The glandular inflammation or lymphadenitis results from the arrest of the causative bacteria in the sieve-like structure of the glands.

When the deep lymphatics alone are inflamed the cutaneous redness is absent and the symptoms are obscure. Glandular implication is the only symptom which enables a diagnosis from cellulitis to be made.

In lymphangitis the constitutional symptoms are rigors, high temperature and other febrile manifestations, which in septic cases especially are accompanied by great prostration, delirium, and typical asthenic symptoms.

Violent lymphangitis is often, probably always, due to the introduction of putrefactive or other pathogenic bacteria into the lymph current, and is most liable to occur when open lymphatic capillaries are bathed in or subjected to the influence of septic fluids. It is developed not infrequently in connection with dissection wounds, snake-bites, erysipelas, diphtheria, typhus and typhoid fevers, and the puerperal condition. Uterine lymphangitis of a septic character, which may follow labor even when no injury to mucous membrane has been inflicted, is very prone to cause diffuse peritonitis, and is usually fatal. Septic lymphangitis may arise, it would appear, without traumatism by an endosmosis of the poison through the skin.

Patients in enfeebled health are more prone to septic lymphatic inflammation than those of greater resistive power. This form of lymphangitis may run an acute or a chronic course, and is the forerunner of general septicæmic symptoms.

Lymphangitis is to be diagnosticated from phlebitis by the higher febrile temperature of the former, the more vivid red of the cutaneous lines, and the associated glandular inflammation. In erysipelas the discoloration of skin is more diffused than in inflammation of the absorbent vessels.

Treatment.—The treatment of lymphangitis is very similar to that adapted to phlebitis. Septic infection is to be prevented by cleaning and thoroughly disinfecting wounds at the time of their reception. If the existence of poisonous inoculation is suspected at the time, as is the case in dissection wounds, suction and cauterization should be employed. Absolute cleanliness and antiseptics should be enforced on the part of those examining and attending puerperal cases, since septic uterine lymphangitis is almost uniformly fatal. Local applications may be made along the course of the inflamed absorbent vessels when superficial. Moist

antiseptic dressings, equal parts of extract of belladonna and glycerin, fomentations containing morphia or other narcotics, and mercurial ointment have been recommended as topical measures. Pencilling with nitrate of silver and wrapping in dry cotton have advocates. The limb should be kept elevated and at rest. Free incisions to evacuate pus must be promptly made. Constitutional remedies of a supportive kind are always judicious. Quinine, iron and morphia, and often alcohol, are the drugs to be used. Œdema remaining after subsidence of the acute symptoms is to be treated by pressure with the elastic bandage, massage and passive motion of the joints.

Lymphadenitis.

Pathology.—Inflammation of a lymphatic gland, called lymphadenitis or simply adenitis, may occur without the existence of lymphangitis; but lymphangitis, as previously stated, rarely occurs without an accompanying lymphadenitis. The retentive or sieve-like function of the lymphatic glands is the cause of their frequent implication secondary to inflammation of the lymph vessels. All material conveyed along any of these ducts is compelled to pass through the reticular or net-like structure of the corresponding glands. Here pigments from tattooing, septic particles, whether bacteria or emboli, poison from syphilitic or other inoculated wounds, cells from malignant growths, pus and abnormal lymph cells are filtered out of the retarded lymph current and remain to choke up the network of small spaces and channels of which the glands are in large part formed. When these filtered-out particles cause stasis of the current, coagulation of lymph and inflammation of the gland structure, then lymphadenitis, with its characteristic swelling, hardness, and tenderness, exists.

Causes.—Lymphadenitis then may be caused by direct irritation or injury to the gland or by any peripheral lesion or absorption that sends irritating substances to the gland. The lymph vessels between the periphery and the gland may be free from involvement, even though they have carried the irritative cause in the lymph current flowing through them. Lymphadenitis may be acute or chronic, and is due to infection by the tubercle bacillus, pyogenic organisms, and other bacteria, as well as to direct injury. The character of the inflammation depends on the cause and the constitution of the patient.

Symptoms.—The symptoms of acute suppurative lymphadenitis are swelling and tenderness of the gland, lancinating pain increased by motion, and fever. The connective tissue around the gland becomes implicated in the inflammatory process, the overlying skin assumes a red and glazed appearance, and suppuration begins in the centre of the gland or in the surrounding cellular tissue. Spontaneous evacuation of pus finally occurs through an irregular orifice surrounded by thin purplish skin, which after a prolonged period of cicatrization heals, leaving an ugly, puckered cicatrix adherent to the deep tissues. Cure by resolution without suppuration takes place in some instances of acute lymphadenitis, but it is so usually due to pus infection that the formation of pus is very common. Sometimes the tissues around the gland suppurate and on evacuation leave the inflamed gland exposed in the wound as a reddish-gray mass. Tubercular lymphadenitis, with burrowing of puriform fluid and the formation of sinuses, is not very infrequent. In some cases tubercular adenitis assumes a very chronic course, being accompanied by

glandular swelling, induration, and hypertrophy without pain or fever or tendency to degenerative softening. In some regions of the body the lymphatic glands are scarcely perceptible by palpation through the skin until they become enlarged by inflammation, when the nodulation produced by them is sufficient evidence of adenitis. The inguinal bubo occurring after syphilitic inoculation affords a good example of the behavior of adenitis. If a whole group of glands is inflamed, the obstruction to lymphatic circulation causes œdema of the peripheral regions. This may become established if the adenitis is chronic.

Septic lymphadenitis differs from simple acute lymphadenitis in its higher febrile movement and much greater danger to life.

TREATMENT.—Acute lymphadenitis requires absolute rest of the part and antiseptic fomentations; blisters, or tincture of iodine painted around the inflamed gland may be serviceable. Pus should be evacuated by free incision, and the diseased gland and tissues removed by curetting. Carbolized oxide of zinc ointment, iodoform, and similar applications will facilitate cicatrization of the resulting ulcer, which may become chronic and intractable. All sinuses should be laid open and scraped. Chronic adenitis with its characteristic hypertrophy is best treated by blisters, tincture of iodine, and firm pressure; the last agent may be applied by means of a specially adapted truss. Interstitial injections of alcohol by means of a hypodermic syringe will often cause absorption and diminution of large glandular masses. Caseous tubercular lymphatic glands should be enucleated, to prevent general infection of the patient; as should single groups of indurated glands producing deformity, such as occurs so frequently in the neck, if internal and local treatment does not dissipate the swelling.

Chronic adenitis demands internal remedies, such as cod-liver oil and iodine. Syrup of the iodide of iron in full doses (♏xxx–xl), quinine, iron, nutritious diet, and sea air are very beneficial, particularly in strumous cases.

Syphilis and malignant and other tumors may affect the lymphatic glands, but these topics demand no special consideration here. The peculiar disease variously called lymphadenoma, Hodgkin's disease, adeno-lympho-sarcoma, and malignant lymphoma, which is attended by enlargement of many groups of glands and profound anæmia, is a medical rather than a surgical affection.

Varicose Lymphatic Vessels.

Varicosity, or dilatation of the lymphatic networks gives rise to small transparent vesicles, like boiled sago grains, which are more frequently seen upon the inside of the thigh, and upon the genitals and the abdomen than elsewhere. When the superficial lymphatic trunks are the subject of this infrequent condition, the dilated portions give rise to larger and more elongated swellings.

There is usually œdema of the peripheral parts. Lymphatic varicosities can readily be emptied of their fluid contents by pressure.

Arabian elephantiasis is at times complicated with lymphatic varicosity. Cystic dilatation of the lymphatic ducts occurs at times in the tongue, lips, and neck.

A tumor formed of a congeries of dilated lymphatic vessels and similar in structure to the arterial and venous vascular tumor, or angioma, is occasionally developed. It is appropriately called a lymphangioma.

Rupture or wound of a dilated lymphatic vessel is liable to be followed by lymphorrhagia, or a prolonged discharge of lymph. If a fistula result, cauterization and pressure are proper.

Lymphatic dilatation usually needs no treatment. The methods adopted in corresponding venous changes would be applicable.

Injuries and Diseases of Arteries.

Wounds of Arteries.

Pathology.—After contusion of arterial coats there is a liability to ulceration and secondary hemorrhage, which occurrence will, in open wounds, demand prompt ligation at both sides of the bleeding orifice. If the contusion has occurred subcutaneously, the ulcerative action will allow extravasation into the muscular and cellular tissues, which, if extensive, may call for incision into the tissues and ligation of the vessel at both sides of the wound, for ligation above the seat of injury, or for amputation of the limb.

By the advent of inflammation or thrombosis, a bruised artery at times becomes obliterated at the seat of contusion, and this occlusion may give rise to gangrene or visceral degeneration. Aneurism also may be developed after contusion of an artery.

Slight contusions of arteries may occur without marked pathological consequences. The elasticity of the vessels, and their relations to surrounding parts often protect them from such violence.

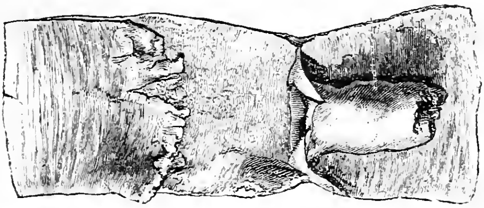
Arteries may be torn completely asunder subcutaneously by violent manipulation, as in reducing old dislocations, or by accidental injuries. The extravasation which follows may be absorbed as the torn ends of the artery become sealed by obliterative inflammation, or it may become surrounded by a capsule or sac, consisting of cellular tissue thickened and condensed by pressure and inflammation. The extensive character of the subcutaneous bleeding may cause violent inflammation, and its interference with the peripheral circulation may, because of pressure, lead to gangrene. Amputation is at times demanded for such sequences of arterial rupture.

Subcutaneous extravasation of blood, from spontaneous or traumatic rupture or direct wound of an artery, is sometimes termed "aneurism." The term, even though qualified by the words false or traumatic, should be rejected, as it is misleading as well as unscientific. When the effused blood becomes encapsulated and the communication with the artery persists, the resemblance to aneurism is, however, great. Then the term is not altogether inapplicable, though the condition is not strictly an aneurism but an arterial hæmatoma.

Complete laceration, or tearing asunder, of an artery in an open wound may be unattended by hemorrhage because of the twisting and tearing of the coats at the time of injury. It is well, however, to ligate such vessels before the first dressing is applied if they are seen pulsating in the wound. The two inner coats of an artery are sometimes torn in subcutaneous injuries, while the external tunic by reason of its elasticity remains intact. This partial rupture may subsequently become complete by the giving way of the outer coat, and be followed by fatal extravasation. On the other hand, the torn coats may curl up, cause coagulation within the vessel, and thus lead to permanent occlusion, or to arrest of

circulation and consequent gangrene. Gangrene may arise also from the torn shreds acting as a valve and at once shutting off the blood-flow to the parts beyond. Sometimes the injured region remains as a weak spot or cicatrix which finally becomes the seat of aneurism due to a traumatic cause.

Fig. 98.



Laceration and turning backward of inner coats of an artery, due to injury. (Bryant.)

Wounds of arteries, inflicted by sharp instruments or spiculas of bone, may, under rare circumstances, involve only the outer and part of the thickness of the middle coats. Such non-penetrating wounds give rise to no primary bleeding, but almost invariably are followed in a few days by secondary hemorrhage. Hence, partial penetration of arterial walls, when recognized, should be treated by exposure of the vessel, ligation on both sides of the wound, and complete section of the artery between the ligatures. Penetrating arterial wounds, unless inflicted by very fine needles, are followed by hemorrhage, either at once or secondarily from ulceration.

The amount of primary bleeding from incisions into arteries depends on the direction as well as the size of the wound. Transverse wounds allow more gaping and, therefore, more bleeding than longitudinal incisions. Oblique cuts hold an intermediate position. Complete section of an artery is less dangerous in this respect than an incision involving only a portion of the circumference, for the former, by allowing contraction and retraction of the coats, affords an opportunity for spontaneous arrest of bleeding. This is the reason that when cessation of bleeding is desired after arteriotomy of the temporal artery for therapeutic objects, the surgeon completely divides the vessel. Bleeding may at once cease after the division, though pressure is often needed in addition. If this section, moreover, was not done, secondary hemorrhage or traumatic aneurism might occur.

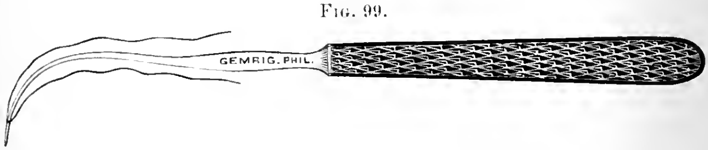
Arterial wounds may be followed by death from external or internal hemorrhage, or may cause suppuration or gangrene secondary to burrowing of the extravasated blood in the cellular tissue. The tissues may cicatrize and traumatic aneurism may be developed as a result of arterial injury. If the corresponding vein is wounded arterio-venous fistula may develop.

Treatment.—The treatment of arterial wounds in the limbs should begin by resort to temporary compression by means of a rubber bandage tightly applied above the wound. The arrest of bleeding thus obtained allows opportunity for enlarging the wound in the superjacent structures, which should be followed by ligation of the vessel on both sides of the wound, and by complete division of the artery at the point of injury. Two ligations are necessary in all such cases, because establishment of the

collateral circulation will render secondary hemorrhage from the distal part of the artery almost certain. Gunshot wounds of arteries require similar treatment.

When the arterial lesion is subcutaneous, or the communication with the air valvular, or when the superficial tissues have healed before the partially divided vessel has given way, large extravasation and burrowing of blood may occur. The symptoms are: Sudden prostration and syncope from the anæmia, and the development of a soft, somewhat elastic and fluctuating tumor, with, perhaps, an impulse, thrill, and bruit similar to what is found in an aneurism. Pulsation in the peripheral vessels may become absent and the limb œdematous and of low temperature. Pulsation will probably not appear in the tumor until the formation of a circumscribing cyst wall has begun. This diffuse extravasation may continue increasing until death results or gangrene occurs. Death may supervene by rupture and a discharge of blood and clots into some cavity, or from the skin giving way, through suppuration and ulceration, and allowing secondary hemorrhage. The treatment of such cases of arterial injury consists in applying pressure to the artery above the wound and over the swelling, keeping the patient in bed and the limb at absolute rest by bandages and splints. The rubber bandage of Esmarch may be used temporarily to occlude the artery. Ligation of the trunk at some distance above the swelling so as to be above the first branch will generally succeed if these measures be inefficient. When it is impossible to obtain absolute rest, or when ligation above the first collateral branch is inapplicable or inefficient, pressure by a rubber bandage above the wound must be made or artificial anæmia by the Esmarch method obtained, the tumor laid open, the clots turned out, the artery completely divided, and both ends secured by catgut ligatures. The easiest way to isolate the artery is to insert a probe into the opening and then dissect the vessel free. The ligature can then be readily passed around it by means of a curved needle with an eye near the point, or by Horner's curved awl, which has a shoulder to carry a loop of string through the tissues and around the vessel. If the circulation cannot be controlled above by the Esmarch

Fig. 99.



Horner's awl.

apparatus, the surgeon must make a small opening in the skin and introduce one or two fingers of the left hand into the cavity of the tumor. Thus he prevents profuse external bleeding by having the cutaneous wound plugged with the fingers with which he feels for and compresses the arterial wound. After getting the opening in the artery closed by digital pressure, he uses the right hand to enlarge the skin wound and then proceeds to turn out clots and ligate. In military surgery and in special cases amputation may be preferable to these procedures.

When the extravasation is comparatively small and has become circumscribed by an adventitious sac of condensed and thickened connective tissue, laying open the cyst wall and tying both ends of the artery will often be quite easily performed, and, being the radical operation, is prob-

ably more judicious than ligation of the artery above the tumor. In the diffuse and profuse extravasations just discussed, ligation above the first branch is probably more judicious than searching for the arterial wound among the structures inundated with partially coagulated blood, and is certainly better than ligation immediately above the injured part of the artery. This position of the ligature is usually allowable only in the small extravasations, where there is little danger of secondary hemorrhage from the distal part of the vessel when the collateral circulation is established.

Surgical interference should not be adopted too hastily in small arterial extravasations, especially when they are subcutaneous or due to fractured bones injuring the artery.

Spontaneous cure may be accompanied by the contraction of the condensed cellular tissue and coagulation of the blood. The encysting process, which causes the development of an adventitious sac, is the first step in such cases. Hence, the surgeon should, when possible, wait until he has decided that nature's efforts at cure are ineffectual.

Traumatic Aneurism.

Varieties.—Traumatic aneurism is a secondary result that occasionally follows arterial injuries. This term has often been improperly applied. It should be restricted to the following conditions :

1. Dilatation of the cicatricial tissue and adjacent arterial wall after a healed penetrating wound of an artery.
2. Dilatation and hernial protrusion of the uninjured inner coats through a wound of the outer tissue alone.
3. Dilatation of the outer tunic after an injury producing rupture of the inner coats alone. Such ruptures are, as a rule, produced only in vessels whose inner coats have been weakened by degenerative changes, such as atheroma. Hence, such cases have an origin which often makes the terms spontaneous aneurism and traumatic aneurism equally inappropriate, since two causative elements are present. In many of these cases it is impossible to arrive at the exact cause, from either the clinical history or symptoms. Fortunately, these are the very instances in which treatment is very little influenced by the character of the cause.

A limited extravasation of blood from puncture of one of the smaller arteries may become surrounded by an adventitious sac, formed by inflammatory condensation and thickening of the normal areolar tissue. This differs somewhat from the diffuse and burrowing extravasation spoken of on a previous page under wounds of arteries, and has more right to the title "traumatic aneurism." Still it is not strictly an aneurism, though it is a blood tumor which pulsates and has a thrill and bruit. It is nothing but an encysted extravasation of blood; or, in other words, an arterial hæmatoma.

An aneurism is a circumscribed dilatation of one or more of the arterial coats, induced by the distending influence of the blood current upon abnormal vascular walls. The condition being discussed having no such pathological nature, should not be called an aneurism. To call it a "false" aneurism would be illogical, since what is a false aneurism is evidently no aneurism.

Treatment.—The proper treatment of traumatic aneurism is compression of the artery as near as possible to the sac; or, in the event of this procedure failing, ligation in the same situation.

Small or superficial traumatic aneurisms may be treated by incision of the sac and ligation of the artery on both sides of it. Dissection of the tissues so as to expose the sac and the artery, followed by ligation on both sides without opening the sac, is a good modification of the same method.

The different methods of ligation, described in the section on the treatment of spontaneous aneurism as Hunter's, Wardrop's, and Brasdor's methods may sometimes, on account of the location of the tumor, be preferable to ligation immediately above the sac.

Arterio-venous Wounds and Fistules.

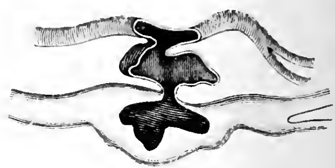
Definition and Pathology.—Puncture or gunshot wounds simultaneously penetrating an artery and an adjacent vein are liable to be followed by a persistent orifice of communication between the two blood-vessels. Such fistulous communications which may form slowly have been improperly called arterio-venous aneurisms.

When the lips of the arterial wound remain in contact with and become closely adherent to those of the adjacent vein, a direct fistulous opening is established between the calibre of the artery and that of the vein. When the wall of the vein is pushed away from the wall of the artery and the extravasated blood burrows between them, a pouch or sac is developed, which communicates on one side with the artery and on the other side with the vein. The former condition has been termed aneurismal varix; the latter varicose aneurism. Neither of them is an aneurism, for they

Fig. 100.

First form of arterio-venous fistule. (Wyeth.)

Fig. 101.



Second form of arterio-venous fistule. (Wyeth.)

are not circumscribed dilatations of one or more of the arterial coats induced by the distending influence of the blood current upon abnormal vascular walls. Hence, to class them together under the general heading arterio-venous aneurism is obviously improper. The first form is exhibited as a varicose vein or varix, with pulsation; and, therefore, may, perhaps with some degree of propriety, be called an aneurismal, or better, an aneurismoid varix. The second form is in the development of its adventitious sac identical with the encysted extravasation or arterial hematoma described on page 252, which I there said was improperly termed a traumatic aneurism. Hence, it has somewhat more right to be classed with aneurisms than the first form. I prefer to use the terms simple arterio-venous fistule, and sacculated arterio-venous fistule to describe the two forms of preternatural arterio-venous communication.

Arterio-venous fistules of both kinds very occasionally arise without traumatism. Ulceration or an abscess may open a contiguous artery and vein and permit the establishment of a direct or indirect orifice of communication. Again, a true aneurism may cause thinning and perforation of a vein upon which its sac presses. In this case, however, the

condition is a sequence and complication of aneurism, not a new disease deserving a special name.

Simple Arterio-venous Fistule or Aneurismoid Varix.

Symptoms.—Aneurismoid varix is a dilated condition of a vein due to a direct fistulous aperture between it and an artery. It appears as a small, soft, bluish tumor, readily disappearing on pressure, which is the seat of a peculiar tremulous jarring or vibratory pulsation, and a characteristic continuous but remittent purring murmur. The vibration and murmur are due to the injection of a small stream of arterial blood into the vein through a narrow orifice at each pulsation of the artery. This forcible blood current, by greatly increasing the intravenous pressure opposite the orifice of communication and by antagonizing the upward flow of venous blood, causes marked distention of the vein at the site of the fistule, and leads to varicosity of other veins in the vicinity.

The vibration and murmur may be transmitted along the veins to a considerable distance from the opening; especially is this the case in an upward direction. The swelling, vibration, and murmur are lessened by elevation of the limb, increased by its being placed in a dependent position. Digital compression of the vein at the cardiac side of the tumor increases these phenomena, but similar compression on the distal side exerts no influence whatever. Compression of the artery above the swelling causes immediate arrest of vibration and murmur, which are at once reëstablished upon removal of pressure. Pressure upon the artery below may be expected to increase the size of the swelling.

The arterial trunk above the seat of disease may after a time become enlarged and pulsate more vigorously than the corresponding vessel of the opposite limb; but below the aneurismoid varix the artery and its branches become smaller and show diminution of the normal pulsation. The limb below the disease is usually weak and of lower temperature than normal. It may exhibit a hypertrophic condition of the skin, nails, and hair, and become the seat of œdema, ulceration, hemorrhage, and perhaps gangrene. These secondary changes are due to interference with the normal circulation.

Aneurismoid varix of the scalp is sometimes followed by such a general hypertrophy of the venous and arterial branches that a mass of convoluted and pulsating vessels is formed which cannot be distinguished from arterial varix, the so called cirsoid aneurism.

Simple arterio-venous fistule or aneurismoid varix is usually an affection of slow progress. If it does not increase nor annoy by reason of its bulk or murmur, it requires no treatment.

After arterio-venous punctures, which by the way have not infrequently been received during venesection at the elbow, the possible occurrence of fistule should be remembered and an attempt to prevent such a sequence should be made by applying pressure to the wound and also to the artery above the injury.

Treatment—If curative treatment is deemed necessary, continuous digital pressure upon the tumor directly over the orifice should be made.

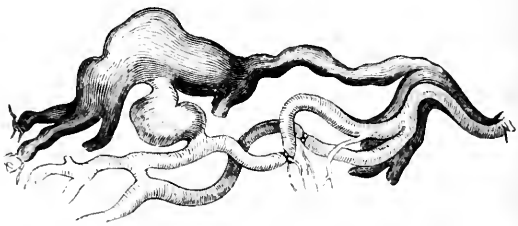
The use of the rubber bandage may be advantageous if so applied as to stop the circulation through the limb, and yet leave the tumor filled with blood. Coagulation and consequent occlusion of the orifice may possibly be thus effected. Many cases will resist both of these plans of

treatment. Then resort to ligation is justifiable in severe cases of the disease. The artery should be tied above and below the opening with catgut. The vein should be carefully separated from the artery at the point of ligation and left unmolested, since its ligation or destruction greatly increases the risk of gangrene of the already poorly nourished limb. In such a locality as the thigh, where the integrity of the femoral vein is so essential, it is better to omit placing the lower ligature on the artery and trust to elevation of the limb rather than to endanger the vein by rudely endeavoring to separate it from the artery. It sometimes requires great care during the operation to distinguish the thickened and pulsating veins from the artery.

Sacculated Arterio venous Fistule.

The so-called varicose aneurism is not an aneurism, but is a sacculated arterio-venous fistule, differing from the aneurismoid varix or simple arterio-venous fistule in having a sac or pouch between the artery and vein, from which there is one opening into the artery and another into the vein. In this sac, which is due to inflammatory condensation and thickening of the normal connective tissue, the arterial and venous blood currents meet and intermingle.

FIG. 102.



Sacculated arterio-venous fistule. (ERICHSEN.)

SYMPTOMS.—The clinical history differs from that of simple arterio-venous fistule or aneurismoid varix in having certain additional symptoms. The same venous varicosity exists and the same vibratory or jarring motion, and purring murmur are present in the veins, though less marked than in aneurismoid varix, because the arterial stream is not forced directly into the vein. A tumor more or less solid can often be perceived lying between the two vessels. This is felt to be the seat of a pulsation synchronous with the arterial pulsation and distinct from the tremulous jarring of the distended vein. Auscultation reveals a blowing murmur, like that of a true aneurism which is additional to the purring murmur, due to the blood entering the vein. Œdema, cutaneous hypertrophy, ulceration, and other nutritive changes may occur, as in aneurismoid varix. The sacculated arterio-venous fistule differs from the simple in its greater tendency to be progressive; and, by the distention and enlargement of the sac, to lead to sloughing of the skin and fatal hemorrhage. The sac, as a rule, gradually becomes somewhat hard from internal fibrous deposition, and, indeed, this process occasionally causes spontaneous closure of the venous openings and simplifies the treatment of the disease. The progressive character of the condition is such that treatment is nearly always demanded.

TREATMENT.—Means to obliterate the sac should usually be under-

taken if the diagnosis from aneurismoid varix has been established. This differential diagnosis at times may be difficult. Digital or instrumental compression of the artery above the disease, combined with pressure directly upon the opening into the vein, should be the first resort. A similar method is to apply the rubber bandage tightly from the fingers or toes up to the tumor, to carry it with only moderate pressure over the tumor and finally to constrict the limb tightly above the seat of the disease. Thus the sac is left full of blood which, by the arrest of circulatory movement, is given an opportunity to coagulate and thus induce obliteration of the sac and closure of the fistulous apertures. Pressure, if it does not cause a radical cure, may at least close the venous opening and thus reduce the lesion to a more simple and manageable condition.

When pressure fails, ligation of the artery immediately above and below the sac is the proper procedure. The coats are usually healthy, since the condition is due in nearly every instance to a wound. Hence, the ligatures can be applied near the seat of disease. The neck of the sac also, if accessible, may be tied close to the artery. When the shrunken lower part of the artery cannot be found, it may become necessary to lay open the sac. A probe can then usually be passed down the vessel through the aperture connecting the sac with the calibre of the artery. In such operations it must be remembered that if the vein is first laid open, the surgeon sees only the venous opening into the sac. A second incision is then required to open the sac and disclose the arterial orifice. Care should be exercised to avoid tying or tearing the main veins of the limb. Such a complication adds to the risk of gangrene. When such venous interference is unavoidable in old and feeble patients, amputation will probably be preferable to the double ligation. In all these operations the rubber bandage should be applied as a preparatory step.

Coagulating injections into the sac after immobilizing the blood by an elastic bandage have been suggested. The method by ligation is probably less dangerous, and at the same time more radical in principle.

Arteritis and Degenerative Changes in Arteries.

Pathology.—Inflammation of arterial walls, if acute. usually involves, sooner or later, the three coats; but the pathological changes may begin or become more marked in any one of the tunics. Hence, we have the terms endarteritis, mesarteritis, and periarteritis expressing inflammation of the inner, middle, and outer coats respectively. Chronic arteritis affects principally the inner coat. Arteritis is caused by external or internal violence, such as wounds or lodgement of emboli; by extension of inflammation from surrounding tissues, as in phagedena; and by the constitutional states that induce impaired nutrition, such as syphilis, rheumatism, gout, alcoholism, and renal disease. The results that may follow arteritis are fatty degeneration, atheroma, and calcification of the tunics; occlusion or aneurismal dilatation of the calibre of the vessel; and suppuration, ulceration, or perforation of the vascular wall. The organs and structures supplied by the inflamed artery may suffer by loss of function and become the seat of gangrene secondarily to these sequences of arteritis.

The pathological changes found in traumatic arteritis are similar in character, whether they begin externally or internally. The inflammatory process commences in the tunic injured, but, as a rule, soon spreads to the

other coats. Internal violence, such as is produced by the impinging of the blood-current or by the impact of an embolus, is more apt to induce an inflammation limited to one tunic than is external violence, which usually injures all coats simultaneously.

Traumatic arteritis from external causes must necessarily be accompanied by contusion, laceration, or some such complicating lesion of the periarterial structures.

The pathological alterations seen in arteritis are very like those which have been detailed as occurring in phlebitis. The external tunic of the artery becomes unusually vascular, and is swollen from infiltration by serum and white corpuscles that have migrated out of the vasa vasorum. These changes cause thickening and softening. The middle and internal coats also are thickened and softened and the site of cell proliferation. The internal tunic loses its smooth, glistening appearance, is elevated in patches which are sometimes the seat of erosions, and usually becomes pinkish in color. The calibre, or lumen, of the vessel is lessened by the swelling of the coats, the projection inward of the inner tunic, and probably also by spasm of the inner coat. When there is rupture of the internal tunic, as happens in ligations and other injuries, there will be more encroachment and even occlusion of the lumen, for the roughened and projecting margins will cause fibrinous deposition. The formation of a coagulum consisting of white corpuscles and fibrin occurs in arteritis as in phlebitis, though less often, even without previous rupture of the inner coat. It is much more unusual in acute than in chronic arteritis. In syphilitic arteritis it is not infrequent. As in phlebitis the thrombosis is at times the cause, at others the result, of arteritis.

When complete occlusion of the artery and arrest of the blood-current are produced by the pushing inward of the internal coat and by the deposition of cells and fibrin, permanent obliteration of the vessel may take place from organization of the cells of the coagulum as was formerly believed, or from organization of the newly-formed tissue springing from the normal cells of the internal coat. There occurs thus a species of cicatricial contraction which converts the former arterial tube into an impervious, fibrous cord. Sometimes, however, the clot, on the other hand undergoing fatty degeneration, is washed away as minute particles of fat which do no harm, and the artery regains its normal patulous condition. Sometimes fragments of the clot are detached, and as emboli are carried onward until they plug some distant artery of smaller calibre. There they may be absorbed or may produce local anæmia and infarction. At other times disintegration of the primary coagulum occurs, due to septic or pyogenic bacteria, and septicæmia or multiple infective embolism and pyæmia may result.

When suppuration and ulceration occur, as happens at times in septic traumatic arteritis, there is great liability of perforation and hemorrhage unless the previous occlusion of the artery by a coagulum has been complete. Suppuration in the outer coat is generally diffuse, but in the middle tissue it may be localized as distinct abscesses. Pyæmic infarction is readily induced if septic material from suppuration of the vascular walls or of the surrounding structures gains entrance to the blood current. The hyperplasia of connective tissue, which may take place in the middle coat as a sequence of arteritis, causes atrophy of the muscular and elastic fibres, and renders the vessel less able to resist the distending influence of blood pressure; hence, subsequent aneurismal dilatation may occur at the seat of the former arterial inflammation. Infective emboli, causing acute

inflammation and softening, are believed to be a frequent cause of aneurism when occurring in the young.

Idiopathic arteritis is usually associated with and a result of inflammation of the structures surrounding the vessel, unless it be due to syphilis, gout, or some similar dyscrasia. Many cases denominated idiopathic arteritis are really instances of traumatic inflammation, caused by the impact of the blood current, or of emboli from cardiac vegetations against the internal arterial coat. Such are the cases of endarteritis and resulting fatty degeneration not infrequently found at the great sinus, the transverse arch and the bifurcation of the aorta, and in the innominate artery. Idiopathic arteritis presents pathological changes similar to those seen in traumatic cases.

Syphilitic arteritis is a chronic inflammation, and occurs especially in the smaller arteries. The vessels of the brain are particularly liable to it, and on account of the resulting circulatory interference the disease is a serious one in this locality. Aneurism may be due to syphilitic arteritis of the aorta and larger vessels. The pathological changes arise chiefly in the internal tunic, which by reason of the inflammatory proliferation of cells projects into the lumen or calibre of the vessel, and causes great narrowing or complete occlusion of the blood channel. Death from cerebral anæmia thus induced is not very infrequent. It is often impossible during life to diagnosticate syphilitic arteritis from atheroma. In fact, both diseases may exist at the same time. Atheroma is more common in the old than the young, and causes arterial weakening and dilatation rather than occlusion. Atheroma is not so apt to attack the smaller vessels as is syphilis. After death microscopic examination shows that atheroma has a greater tendency to involve all the coats than syphilis, which is usually more or less limited to the internal coat.

Rheumatic arteritis is said to be rare. That it has not been studied as carefully as the other forms may be the reason for this supposition. Rheumatic inflammation of the lining membrane of the heart, which is similar to the lining coat of arteries, is certainly common. Mechanical strain put upon the coats of the vessel by reason of increased or unusual intravascular pressure is a cause of chronic arteritis. These chronic forms of arteritis are all allied to degenerative processes, and have few well-marked symptoms.

Symptoms.—The symptoms of arteritis, when more or less acute, and the accompanying thrombosis are severe pain, tenderness and hyperæsthesia in the course of the vessel and in the parts supplied by it, and impairment of muscular power. This pain may resemble rheumatism. The surface temperature is lowered, and the skin perhaps mottled. When the vessel is superficial, a hard, pulseless cord may be felt or seen through the skin; if only partial occlusion has taken place, a jerky pulse may be perceptible. Secondary gangrene, with its characteristic symptoms, may arise from the interruption of circulation, especially in the old and feeble.

Treatment.—The treatment of arteritis consists in rest, wrapping up the limb in cotton to maintain heat, administering opium to relieve pain, and using tonics, stimulants, and good food to prevent depression. As gangrene is a not unusual sequence, the husbanding of vital resources is required. This precludes the use of depressants in the early stages, unless the patient is unusually vigorous and the disease so situated as to render subsequent gangrene limited. Measures to obviate gangrene and to avert fatal hemorrhage from ulcerative perforation are to receive careful consideration. Syphilitic, rheumatic, gouty, and other forms of arteritis

should be treated with mercury, iodide of potassium, alkalies, salicylic acid, colchicum, etc., with a view both of preventing further progress and of perhaps effecting cure. Microbic invasion of wounds must be prevented by rigid asepsis and antisepsis, since it has been shown that septic discharges are the chief cause of ulcerative and suppurative arteritis.

Atheromatous Degeneration and Calcification of Arteries.

Any form of chronic arteritis may terminate in atheromatous degeneration of the vascular walls. This condition is due to malnutrition of the arterial tunics, and is a fatty degeneration of their cellular elements. It occurs as a secondary lesion following chronic inflammation of arteries, and is frequently found in syphilitic and senile subjects. It differs from the primary and localized fatty change belonging to the pathology of endarteritis in being a secondary lesion, which affects the arteries generally, and which is liable to give rise to thrombosis, embolism, and hemorrhage. The destructive process, moreover, causes infiltration not only of the inner coat, but also of the muscular and elastic coats, transforming the normal elements into granular material. Atheromatous degeneration is seen, on examination of the inner surface of the vessel wall, as numerous definitely-outlined, soft, pulpy patches, which are scattered throughout the arterial system. The pulpy material found in the centre of these softened spots gives the name atheroma to this peculiar molecular destruction, and under the microscope is found to consist of fatty and granular matter, mingled with cholesterin crystals and shreds of fibrous tissue. The middle coat soon becomes infiltrated with fatty particles, and the outer one also undergoes degeneration.

The weakening of the vascular wall may allow the blood pressure to cause aneurismal dilatation or rupture. The softening of the deep layers of the internal coat may give rise to the so-called atheromatous abscess; if the superficial layer is destroyed the atheromatous ulcer remains.

At times calcereous degeneration of the tunics occurs as a secondary and conservative process, as if nature was endeavoring to counteract the effect of the softening influences of atheroma. Calcification is more frequent when the atheromatous change is slowly progressing, and the two processes may be going on together at the same time in the same locality. The chalky change begins in the inner and middle coats, but the entire vessel wall may be converted into a calcareous cylinder, though isolated plates of calcification are much more common. By the washing away of the pulpy or atheromatous material on the inner surface the calcareous plates may be uncovered; and sometimes the blood current gains entrance beneath the chalky portion of the wall, and by a species of dissection separates the tunics, or their different layers, and thus creates the so-called aneurism by dissection.

The atheromatous and calcific degeneration causes arteries to become brittle and inelastic and roughened on the interior and exterior, and thus predisposes to loss of function and rupture, by which hemorrhage, occlusion, and gangrene may arise. It is a common senile change, and is particularly liable to occur in the arteries of the brain and in the main arteries of the trunk and limbs. It is not uncommon as a ring about the root of a large branch. Ligation of such diseased vessels is apt to be followed by secondary hemorrhage from the ligature cutting through the brittle walls. A broad, flat ligature to produce mere apposition of the

arterial walls is proper under such circumstances. The weakening of the middle coat induced by atheroma is a frequent precursor of spontaneous aneurism.

Some writers believe that the calcareous degeneration of arteries in the aged is not secondary to atheroma, but is a primary change, and occurs in the middle coat first; while that secondary to atheroma begins in the internal coat.

True ossification of arteries seldom, if ever, occurs. Cases so denominated are probably instances of calcification. These degenerative changes cannot be arrested by any special line of treatment. The indications are to keep up nutrition, to avoid severe exercise, which causes increased blood pressure in the brittle arteries, and to perform none but necessary operations, because of the imperfect circulatory supply and the tendency to secondary hemorrhage.

Aneurism.

Definition.—An aneurism, strictly defined, is a circumscribed dilatation of one or more of the arterial coats, induced by the distending influence of the blood current upon abnormal vascular walls.

This definition properly excludes:

1. General dilatation with elongation of an artery (often called cirsoid aneurism, varicose artery, arterial varix).
2. General dilatation of small arteries and of capillaries (often called aneurism by anastomosis).
3. Arterial venous fistule (usually called arterio-venous aneurism).
4. Separation of the arterial tunics by the blood current (usually called dissecting aneurism).
5. Extravasation of arterial blood due to spontaneous rupture (one of the forms of so-called false aneurism).
6. Extravasation of arterial blood due to wounds and injuries (called by some writers a form of traumatic aneurism).

These widely different pathological conditions often receive, though improperly, the name aneurism because they are tumors containing blood or blood-clots. They are not aneurisms according to the definition that I have given, and as they present symptoms and require treatment different from aneurism I have discussed them in their appropriate places elsewhere.

Varieties.—If the conditions mentioned above be excepted, there are only two forms of aneurism—the tubular or fusiform and the sacculated or sacciform.

Separation of arterial coats, which occurs at times as a result of arteritis by the blood insinuating itself between the layers of the middle tunic or between the inner tunic and the middle, is, under the name "dissecting" aneurism accepted by most writers as a form of aneurism. I prefer, however, to reject it, since it differs from aneurism in every essential feature. It occurs chiefly in the aorta, which may show the separation through nearly its entire length. The blood current may separate the coats for a long distance or form a circumscribed sac within the thickness of the arterial wall. The blood may finally burst through the outer surface of the wall, and cause hemorrhage into the cellular tissue, or into the pericardial, pleural, or abdominal cavity. Sometimes the diverted current re-enters the calibre of the vessel through an opening, due, as was the opening of exit, to a patch of atheromatous softening. This tun-

nel-like channel, with the consequent thickening of the vessel wall, may cause the artery to present the appearance of being double. It would be possible for the separated coats to bulge into the calibre of the artery, and by occlusion cause gangrene of the parts below. It is readily seen that this separation of arterial coats is very different from aneurism, and only corresponds to the definition of aneurism when a distinct circumscribed sac is formed within the thickness of the vessel wall. This is of exceedingly rare occurrence. It is, therefore, better to limit the term aneurism to the two forms, tubular and sacciform, and dismiss the term dissecting aneurism entirely, using instead the words separation of arterial coats.

Fig. 103.

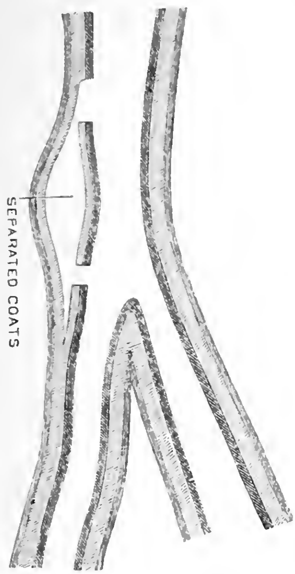


Diagram showing separation of arterial coats, often called dissecting aneurism.

A fusiform or spindle-shaped aneurism is a dilatation or expansion of the entire circumference, and usually of all the coats of an artery, while a sacciform aneurism is a sac or pouch consisting of one or more of the coats developed upon one side of the artery, and communicating with the interior of the vessel by a narrow opening.

Fusiform aneurism is much less common than the sacciform variety, and is chiefly met with in the aorta, and in the iliac and femoral arteries. The dilatation, though not always uniform, is usually more marked at the middle of the tumor and diminished toward each extremity until the normal calibre of the artery is regained. This gives the aneurism, which necessarily has an opening of entrance and one of exit, a spindle shape. The walls of the tumor consist of degenerated and thickened arterial coats with a roughened inner surface. There is some increase in the length of the artery at the dilated and hypertrophied spot. This form of aneurism, unlike the sacciform variety, does not, as a rule, enclose laminated fibrine. Chronic arteritis with its consequent atheromatous degeneration of the arterial walls is the chief factor in the causation of such aneurisms. Traumatic fusiform aneurism seems to me to be almost an impossibility. Occasionally several fusiform aneurisms are developed in connection with the same artery, which is of normal calibre between the dilated regions. The lateral blood pressure in fusiform aneurisms is comparatively moderate in amount; hence they grow slowly and do not readily burst; but it is not unusual for a sacciform aneurism to be developed upon the surface of a fusiform dilatation and to cause death by rupture. In cases of very large fusiform aneurism of the aorta death may also occur from syncope, because the heart is unable to give sufficient forward motion to the mass of blood contained in the large tumor. Hence the circulatory movement in the more distant vessels is impaired and fatal syncope may supervene.

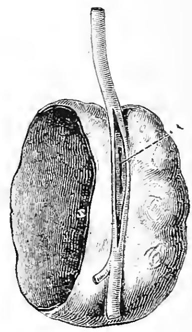
The sacciform aneurism is the most common variety of the disease, and is that which is meant when the simple term "aneurism" is used. Fusiform aneurisms are so infrequent, and in comparison with the sacciform

variety so unimportant surgically, that I shall scarcely refer to them again. My subsequent remarks, therefore, will refer to sacciform dilatation of arteries.

A sacciform aneurism is a sac or pouch developed upon one side of an artery by localized dilatation of the arterial wall and communicating with the interior of the vessel by a narrow orifice or mouth. The cavity of the sac has a much greater diameter than its orifice of communication with the artery, and it is, therefore, usual to speak of the body, neck, and mouth of the aneurism. The walls of the sac may, if the tumor is small, consist of all three arterial tunics; but usually it is only the outer tunic, and perhaps part of the thickness of the middle tunic that form the sac.

As internal pressure causes further distention, the tunics become blended and finally may disappear at places and be substituted by an adventitious wall of condensed and newly-formed cellular tissue. Sacciform aneurism may be developed upon the surface of a fusiform aneurism, which is, as has been seen, little more than a diseased and greatly enlarged artery.

Fig. 104.



Sacciform aneurism from injury. The artery laid open to show opening into sac. (Bryant.)

Causes.—Any agency that lessens the power of the arterial wall to resist the stretching influence of the blood impelled by the cardiac impulse, and any circumstance that diminishes that normal elasticity by which the artery contracts as soon as this stretching influence is relaxed must predispose to aneurismal dilatation. Hence the degenerative fatty change known as atheroma, which occurs in the arterial tunics as a result of arteritis, is the chief factor causing a predisposition to aneurism. Anything that induces the atheromatous change, such as advancing age and alcoholic intemperance, may be an indirect cause of aneurism. Unusual muscular exertion, by inducing violent heart action and preventing rapid admission of blood into the capillaries, causes increased intravascular pressure, and thus may be the immediate cause of an aneurismal dilatation If the artery is previously atheromatous the sudden strain causes the inner coat to give way at a point where an atheromatous patch is situated; the fatty pulp, lying under the inner layer of the inner tunic, is evacuated, and thus in the integrity of the wall a breach is made which allows distention to occur under the force of the blood-stream. Continuously laborious occupation is not so dangerous in this regard, for the vessels seem to acquire strength by the gradual accession of great intravascular tension. It is a sudden strain, in vessels unused to such a degree of tension, and which are previously degenerated, that tends to cause such damage.

External violence without a wound, such as blows and concussions, may loosen the membrane covering an atheromatous spot and induce aneurism in much the same way. Internal strain upon the arterial walls is increased by postures which cause flexures of the vessel; by over-tight clothing, especially around the neck; and by the anatomical division of the artery into two branches of nearly equal calibre. The blood-flow is retarded by these conditions, and consequently the lateral pressure is increased. Hence, aneurism is more liable to occur when sudden muscular effort is made or any unusual strain is thrown upon the walls of an artery under such disadvantageous circumstances. Sometimes a "giving way"

sensation is felt at the time of the violent exertion. This is probably caused by a rupture of the middle coat, and may, perhaps, occur in a healthy artery.

There appears to be an imperfectly understood connection between heart disease and the occurrence of aneurism. Embolism is believed by some authors to cause the development of aneurismal dilatation. This is especially so in infective embolism from ulcerative endocarditis and other septic processes. As the aneurism occurs at and not above the point of lodgement of the embolus, the lesion is supposed to be due to a local arteritis resulting from the septic character of the embolus. This is the explanation of the well-known non-occurrence of aneurism in cases of non-infective embolism.

Syphilis has been regarded by some writers as a cause of aneurism. This is doubtful, since syphilitic arteritis seldom attacks the larger arteries, and it is here that aneurism is more commonly met. It is pre-eminently a disease of small vessels. I am, of course, speaking now of surgical aneurism, not of aneurism of arteries of the brain. Finally, wounds of arteries may be followed by aneurism. The subject of traumatic aneurism has, however, been discussed in a previous section, and requires no further mention here.

When an atheromatous spot has given way, as described above, and the pressure does not cause complete perforation of the wall and hemorrhage, it is usually a sacciform aneurism that is developed. When, however, there is an absence of normal and of inflammatory adhesion between the tunics and their component layers, separation of the arterial coats may be induced by the blood current insinuating itself between them. Thus may be caused on rare occasion separation of the arterial coats, the so-called dissecting aneurism.

Pathology.—Dissection of a sacculated aneurism shows on the outside an investment or covering of cellular tissue, resulting partly from inflammatory condensation, partly from atrophy of the muscles and other structures that have been subjected to pressure by the increasing tumor. Within this more or less imperfect investment is found the true aneurismal sac, consisting of one or more of the arterial tunics which have become so thickened, blended, and changed by interstitial growth that it is usually impossible to determine their exact identity. The inner and middle coats can sometimes be recognized by the patches of atheromatous degeneration visible in their structure. In large aneurisms the two inner coats have usually disappeared; indeed, the outer one may be absent in places and its place be supplied by the external investment above mentioned and the laminated fibrine contained in the sac. The true sac is of varying thickness in different regions of the tumor.

It is evident that in all aneurisms, except in the very smallest, there must be a natural growth of the sac wall after the pouch has first been formed, for the area of tissue that constituted the arterial wall at the site of disease could not possibly be stretched so as to form a sac of such dimensions. The irregular thickening and thinning of the sac depend upon the force of the blood current in the aneurism. Where the blood impinges with the greatest force, there will the sac be thinnest. Inside the true sac there will nearly always be found numerous concentric layers of more or less completely decolorized fibrine. The layers of fibrine nearest the sac wall are tougher and more yellow than those nearer the centre of the aneurism, which are softer and somewhat reddish. This laminated fibrine is found especially in those irregular pockets or pouches

of the sac which are away from the rapid current circulating in the aneurism. This deposition of fibrine is encouraged by any agency, whether within the aneurism or eutirely foreign to it, that diminishes the force of the current within the tumor. When fibrine has once begun to form upon the inner wall of the sac it has a tendency to increase by further deposition of the blood. Thus, layer after layer is formed. The outer layers, being the oldest, naturally become more decolorized and tougher. The laminated fibrine is a beneficial provision of nature for, by reason of its tough, fibrous nature, it strengthens the sac wall and acts as a pad to lessen the force of the pulsating blood current, which is tending to distend and rupture the sac. Moreover, it lessens the capacity of the sac, and by its continual deposition tends to fill up and obliterate the cavity of the aneurism. Fusiform aneurisms usually contain little or no laminated fibrine. At the centre of the aneurism, within the concentric layers of fibrine, there will be found a mass of soft, black or reddish-black clot, or a mixture of such clot and fluid blood. This soft clot may be an ante-mortem or a post-mortem formation.

The secondary changes produced by an aneurismal tumor are numerous and are due especially to the pressure exerted by its growth. Thus, œdema, varicose veins, and venous occlusion may occur from pressure on the veins; and neuralgia, paralysis, anæsthesia, obscure pains, and "tired" sensations may result from nervous compression. Aphonia may follow if the function of the recurrent laryngeal nerve is interrupted. Organs are displaced, bones and cartilages eroded and perforated, synovial sacs opened, gangrene of distal parts determined, and many other destructive processes inaugurated before death or cure occurs. Gangrene may be due to pressure causing interference with circulation to the parts below, or to a portion of laminated fibrine or soft clot becoming detached and being washed into one of the distal branches and plugging it.

Symptoms.—The symptoms of aneurism are usually of gradual development, but occasionally it happens that the patient experiences a sensation of something giving way, which is accompanied by a sudden, sharp pain, and is followed by the appearance of a tumor. An aneurismal tumor is usually rounded or oval in outline, and is covered by healthy skin, unless suppuration or ulceration is taking place. These events occur only in the last stages of the disease.

An aneurism gives rise, as does any other tumor of similar size and location, to certain pressure effects. These symptoms are in no way characteristic, and do not aid in establishing a differential diagnosis. In addition there are symptoms depending upon the relation of the aneurismal tumor to the circulation. These are peculiar, and, when found in combination, are pathognomonic of aneurism.

The pressure of an aneurism may give rise to a pain, numbness, muscular weakness, or paralysis, venous congestion, œdema and varicosities, gangrene, obstruction to breathing and swallowing, and many other symptoms due to interference with the function of special organs. Hoarseness, spasmodic dyspnœa, cough or uncontrollable eructation may be produced by pressure upon the laryngeal or other branches of the pneumogastric nerve; facial distortion, deafness, ptosis, or strabismus from similar involvement of cranial nerves; boring pain or even synovitis from erosion and perforation of bones and cartilages, and nutritive changes from involvement of lymphatic vessels or thoracic duct. The pressure effects of an aneurism are apparently more rapidly developed than those of an ordi-

nary tumor of similar size. This is probably due to the pulsating character of the former.

The symptoms due to the circulatory relations of the aneurism may be called intrinsic symptoms, and are five in number, namely, location, change in tension, pulsation, thrill, murmur. An aneurism is necessarily located in the course of an arterial trunk, and cannot be displaced from its connection with the artery. If occluding digital pressure is made upon the vessel below the aneurism, the tumor becomes more tense and less compressible; and if the sac contains but little laminated fibrine and has thin walls, the tumor may even become larger than usual by the stretching influence of the unusual amount of blood dammed up in it. If the entrance of blood into the sac is prevented by pressure upon the artery above the aneurism, the tension is diminished and the tumor becomes comparatively flaccid and compressible. The elastic bandage when tightly applied to the limb, as in bloodless operating, often causes a marked diminution in the size of the tumor. It may do harm, however, by displacing portions of fibrine and causing embolism.

The compressibility or non-compressibility of individual aneurismal tumors is chiefly determined by the absence or presence in them of a large amount of laminated fibrine. The variation in compressibility or tension, observed when the exit or entrance of blood is checked, is due to the degree of distention of the sac by its circulating blood contents. When the sac contains much fibrine, or has a thick wall, this symptom is not well marked.

The pulsation of an aneurism is a peculiar expansive beat, which not only lifts the fingers or hand laid upon the top of the tumor, but drives apart the fingers or hands when the tumor is grasped laterally. This lateral pulsation is due to the fluid contents of the aneurism transmitting the shock of the heart-beat equally in all directions. When the sac is largely filled with fibrine, and, therefore, has little blood contents, this lateral pulsation is less marked, and only a dead thud is perceived. Another peculiarity of aneurismal pulsation is the wave-like movement.

The pulsation does not seem to affect all parts of the tumor simultaneously, but swells up somewhat gradually as if propagated from one point, and then in a similar way subsides. Pressure upon the artery above the tumor arrests pulsation; pressure below it and elevation of the limb have a tendency to make it more marked. Aneurisms with large orifices, and which contain little fibrine, present the most characteristic pulsation. In partially solidified aneurisms the pulsation may be absent or obscure, or may resemble the simple rise and fall of a solid tumor lying upon an artery. Pulsation may also be absent because of rupture of the anuerism, because of inflammatory infiltration between the sac and the surface, because loose clots have plugged the orifice of communication, or because the disease has just been spontaneously cured, and the tumor has not yet entirely disappeared. When the artery is compressed above the seat of disease, so that no blood enters the sac, the tumor, as previously stated, becomes pulseless and flaccid. If the tumor is now grasped laterally, and the pressure upon the vessels suddenly removed, the expanding pulsation by which the sac is instantly refilled, is readily felt and even seen. When the sac has a large mouth, one pulsation distends it fully; if the orifice is small, the sac fills more slowly, but the first pulsations are strong beats.

The arterial pulse below the aneurism is much less marked than on the opposite side of the body. This may be due to pressure of the tumor on

the artery, to arteritis causing occlusion, or to the rigidity of calcification. It is possible that it may also be caused by the large amount of blood in the sac distributing the pulsation and lessening that in the current below. This variation in the two radial arteries is of aid at times in diagnosticating aneurism of the thoracic aorta. Just after the heaving pulsation of an aneurism, the hand of the examiner can often perceive a peculiar tremulous or vibratory movement called the thrill. The thrill is due to the rebound of the blood column, and is said to be more distinct when the artery lies between the sac and the surface upon which the hand is placed.

The last of the five intrinsic symptoms of aneurism is the murmur or bruit. This is an intermittent blowing, rasping, or purring sound due to the blood rushing through the narrow mouth into the dilated cavity of the sac. It is heard by applying the ear either with or without a stethoscope to the surface of the tumor. The tone varies greatly, depending on the size, shape, and location of the orifice, its relation to the sac, and perhaps upon the character of the surrounding tissues. It is most distinct in fusiform aneurisms and sacciform aneurisms with large mouths. It is synchronous with the aneurismal pulsation, and is stopped by pressure on the artery above the sac, but returns as soon as the pressure is removed and the blood allowed to flow into the sac. If the tension of the sac is lessened by elevating the limb or by compression of the artery above the tumor, the murmur may sometimes be heard in cases in which it was previously absent. Increasing the tension by pressing upon the artery below would, on the other hand, have a tendency to diminish the murmur. If the orifice is very small or the sac nearly filled with fibrine there may be no murmur generated. The aneurismal murmur is not infrequently absent, and, indeed, may be present at one time and afterward disappear. A double murmur indicates, according to Erichsen, a sacciform aneurism.

These intrinsic symptoms may not all be present in a given aneurism, but the association of two or more of them usually renders the diagnosis quite clear.

When an aneurism ruptures, permitting the blood and clots to become diffused, the tumor loses its definite outline and becomes rapidly larger. Pulsation, thrill, and murmur become obscure or absent; pain increases, and coldness, lividity, and œdema of the extremity are apt to occur. The subcutaneous hemorrhage may cause syncope. Coagulation of the blood and inflammatory condensation of the cellular tissue may in very occasional instances limit diffusion after the rupture and lead to spontaneous cure of the aneurism. Usually, however, the swelling increases, and the case terminates in gangrene or suppuration, accompanied most likely with hemorrhage.

Diagnosis.—The differential diagnosis of aneurism from other tumors should always receive careful and systematic attention. No swelling near an artery should ever be laid open until the possibility of aneurism has been eliminated by accurate examination.

The pain caused by internal aneurism may, when the tumor is not easily discoverable, be mistaken for rheumatism or neuralgia. Such an error is hardly probable in the external aneurisms that come under the observation of surgeons. There are two circumstances that at times render the differential diagnosis of aneurism troublesome. First, there are pulsating tumors that are not aneurisms; and secondly, there are aneurisms that do not pulsate.

Any solid or cystic tumor or abscess situated over a large artery may

show transmitted pulsation. The pulsation in such cases is not so expansive as in aneurism, but is rather a simple rise and fall which may be diminished or stopped when the tumor is pushed or lifted away from the artery. Flexing the limb so as to relax the deep fascia will probably lessen the pulsation, which, moreover, is sometimes felt only in the line of the artery and not over the entire tumor. There is no murmur, or if any, it is only a dull beating such as is heard when an artery is compressed with a stethoscope. The tension and size of such tumors are not affected by occluding pressure upon the artery above or below the swelling. The suddenness with which aneurisms regain their usual size when arterial pressure on the cardiac side of the tumor is removed is very characteristic, and is not present in tumors with a mere transmitted pulsation.

Cysts or abscesses communicating with a joint, or with the abdominal or any other cavity, may be partially emptied by pressure; but they refill afterward without reference to the arterial circulation. An abscess situated above or surrounding an aneurism will appear as a tumor having pulsation, and some of the other symptoms of aneurism. Such cases are fortunately rare. The aspirator would be available for establishing the diagnosis. If the suppuration is due to rupture of the aneurism the opening between the sac and the pus collection will permit hemorrhage to follow the opening of the abscess. Pulsation is usually feeble or absent in such conditions, and unless the previous history is obtained the surgeon may be misled into laying open the tumor. The fatal bleeding may not occur until some hours after the incision, because the laminated fibrine may for a time act as a barrier. A murmur should be carefully sought in such cases, since it is less likely to be absent than other aneurismal phenomena

Some vascular tumors or angeiomas resemble aneurisms very much. They are apt, however, to have a more spongy feel, and are not so distinctly circumscribed as aneurisms. If the blood is pressed out of such a tumor it returns somewhat tardily and irregularly, causing the tumor to dilate slowly and unevenly, and not with the sudden bound that is seen in aneurisms. Pressure upon the artery below causes no marked increase in size of tumor. The pulsation is not as forcible or as distinct as an aneurism, and it lacks the expansive and wave-like character of the pulsation found in the latter disease. The murmur is more confused and less well defined. The introduction of a hollow needle will probably give exit to blood, but the blood will scarcely spurt as in the event of puncture of an aneurismal sac, nor will the needle be likely to give to the surgeon's hand the sensation of having its end in a cavity.

Malignant tumors, especially sarcomas of the bones, may, when very vascular, assume pulsation. If in localities where aneurism is common the diagnosis becomes at times almost impossible. The history of such growths generally shows that pulsation was not present when the tumor first appeared, and that the growth has recently become of softer consistence than formerly. Careful examination shows that the pulsation is not very distinct, that the murmur is soft and subdued, and that little variation in size is produced by pressure on the artery between the tumor and the heart. The pulsation and murmur after having once appeared do not, as in aneurism, become more conspicuous as the bulk of the growth is augmented; often these phenomena are perceptible only over certain parts of the tumor. Involvement of the adjacent lymphatic glands suggests malignant disease, which, moreover, is apt to be more or less irreg-

ular in outline. In very obscure cases an attempt might be made to remove a small portion of the interior of the tumor for microscopic examination by inserting an instrument such as is used for cutting out pieces of muscle in cases of suspected trichinosis.

Aneurisms that are devoid of pulsation may be mistaken for deep abscesses and for granular, fibroid, and other tumors. The pulsation ceases in an aneurism when spontaneous consolidation has occurred, or when rupture or diffusion of the blood contents has taken place.

An aneurism, when spontaneously cured by consolidation, continues for a long time as a hard mass, which finally shrinks and disappears. Such a mass cannot easily be distinguished from other hard tumors except by the history. A tumor located near an artery, especially if it shows a tendency to decrease, should, therefore, be well scrutinized before any operative treatment for extirpation is attempted. When a small rupture of the sac occurs, the effused blood conceals pulsation, changes the ordinary globular shape of the aneurism, and, by gravitating away from the seat of disease, may make the tumor appear to have a site distant from the line of the artery. Moreover, the superficial veins may become unusually marked, because the circulation in the deep veins is interfered with by reason of the pressure. This circumstance gives the tumor the appearance of malignant disease. Aneurisms, which are the seat of small ruptures, are, therefore, at times diagnosticated from solid tumors with difficulty. The diagnosis is easily made when the rupture is large, for the interruption of circulation in the limb below, the swelling, pain, ecchymosis, and rapidly occurring suppuration and gangrene are quite distinctive. If suppuration occurs around an aneurism, from inflammation due to pressure or to rupture, pulsation may be absent. The careless surgeon may plunge a bistoury into such a swelling and cause fatal bleeding. This has been spoken of above.

Finally, abnormal pulsation of an artery is at times noticeable in conditions of debility and in nervous subjects, and may be mistaken for aneurism. The absence of lateral or expansive pulsation and of a tumor serves to dispel the illusion.

Course and Termination.—Untreated aneurism generally continues to increase in size until death occurs from: (1) Pressure interfering with important organs, such as the trachea, pneumogastric nerve, or heart; (2) syncope, from weakness of cerebral circulation beyond the large sac; (3) embolism of the cerebral arteries from fragments washed from the laminated clots; (4) rupture and hemorrhage; (5) gangrene, from pressure on the vessels of the limb. When an aneurism bursts upon a serous surface the hemorrhage is usually rapid, and occurs through a slit or star-like tear; but when the rupture is upon a mucous surface, the bleeding is apt at first to be intermittent and so slight as scarcely to attract attention as it oozes through a small fissure. Subsequently, on the occasion of some increase in blood pressure from emotion or exertion, a small slough gives way and a sudden gushing hemorrhage supervenes through a small circular apeture. Rupture upon the cutaneous surface takes place, as a rule, by the processes of ulceration or suppuration and pointing as in abscesses. Rupture of the sac may, of course, occur without external communication. In such cases the blood is effused among the muscles and fascias, and commonly leads very promptly to suppurative or gangrenous inflammation.

Occasionally, but rarely, an aneurism is cured spontaneously. Any agency that lessens the blood-current and thereby encourages the deposi-

tion of laminated fibrine and the coagulation of blood in the sac, may be a factor in this fortunate issue. Absolute quiet of mind and body and maladies that depress the general circulation or draw the mass of the blood to a region distant from the seat of aneurism, have this tendency. The aneurism itself or some other tumor may compress the artery above the seat of disease, and thus diminish the current through the sac. Spontaneous cure may also occur from occlusion of the vessel above or below the disease by an embolic plug swept from vegetations in the heart, or from the fibrine in the aneurismal sac; from inflammation of the sac wall, causing within the aneurism the formation of soft clot; from suppuration; from rupture; and from gangrene. Any of these processes may at times fortunately cause sealing of the vessel and obliteration or destruction of the sac; but they are dangerous complications not often attended by such a gratifying result.

Treatment.—The medical or constitutional treatment of aneurism is important, even in those instances that require additional surgical interference. Absolute rest of body and mind must be enforced by keeping the patient in bed in the recumbent position, and free from the excitement of talking. He should be cautioned to avoid rapid or frequent movements of the limbs, and not to rise in bed unless aided by attendants. He should not get out of bed on any pretence. The food should be limited in quantity, and free from stimulating or indigestible ingredients. Very little water or fluid diet should be given. The design of these precautions is to diminish the bulk, and retard the circulatory force of the blood in order that deposition of laminated fibrine in the sac may be encouraged. These objects may be further obtained if the patient is robust and plethoric by a moderate bleeding from the arm, and the administration of aconite and veratrum viride in comparatively small doses. Bromide of potassium, hydrate of chloral, and the other narcotics may be employed here, and also in a debilitated subject to induce circulatory repose. Iodide of potassium has been strongly recommended in the treatment of aneurism. It should be given in doses of 20 to 30 grains two or three times daily.

The medical treatment just delineated is the only treatment applicable to the majority of internal aneurisms, as aneurisms within the cavities of the trunk are called. It should also be employed as an adjuvant to surgical measures in cases of external aneurism. Though cure of any form of aneurism by medical means is rather unusual, amelioration of symptoms and retardation of progressive enlargement are their common sequences. Fusiform aneurisms cannot, but sacciform aneurisms may, be cured by such measures.

Many surgical expedients have been devised for dealing with aneurism. There are but three that possess sufficient value to be discussed in this treatise.

These are:

1. Excision of the tumor, which is applicable to very small aneurisms only, such as occur in the fingers.

2. Compression of the artery above the tumor by instruments, the fingers, flexion of the joint, or the Esmarch apparatus.

3. Arterial ligation.

Galvano-puncture, acupuncture, the introduction into the sac of foreign bodies, such as horsehair or wire, injections of coagulating liquids, such as the iron compounds, manipulation which aims to detach fragments of fibrine and plug the distal orifice of the sac, and the other proposed

methods are either far inferior to, or much more dangerous than the procedures mentioned above. Still it may be justifiable to resort to one of these methods when those recommended are impracticable.

Amputation may be demanded as a last resort in order to save life in aneurisms of the extremities that threaten immediate death from hemorrhage or gangrene.

Excision of the aneurismal sac is applicable only to small aneurisms such as occur in the hands and feet. In these situations excision is sometimes to be employed because the intimate anastomosis of vessels renders solidification of the aneurism by either compression or ligation of the main vessels of the limb difficult. The method is simple. After the application of the Esmarch apparatus the tumor is dissected out as any other growth would be and the vessel tied above and below the seat of dilatation. The wound is then brought together with sutures. A somewhat similar method, which may be called the incision method, is at times justifiable in large aneurisms, though it is seldom employed except in cases of rupture or accidental puncture of an aneurism. After the circulation has been controlled by compression or the Esmarch apparatus, the sac is incised so that the clots can be turned out and the orifice in the artery discovered. Into this aperture a probe is passed to enable the operator to detect the position of the vessel, which is then ligated above and below the opening. The wound is afterward brought together by sutures or packed with some antiseptic dressing and allowed to granulate.

Compression, as a method of treating aneurism, may be applied directly to the tumor, or to the artery, either above or near the seat of disease. Pressure applied directly to the tumor or to the artery on the distal side of the aneurism is seldom effective and needs no further description. Proximal arterial compression is the form adopted in all cases; for even in those in which flexion is employed it is the compression exerted on the artery above the sac that is the chief element of value. Compression of the artery above the aneurism acts by diminishing or completely arresting the flow of blood through the sac. This, in the one case, encourages gradual deposit of laminated fibrine which finally fills the pouch and leads to solidification; and in the other, causes the sac to become filled with soft clot, after which, under the influence of absorptive and contractile influences, the aneurism shrinks and becomes obliterated.

It is probable that here, as in ligation, the more certain and safe treatment is that in which the pressure is so regulated that a small amount of blood is allowed to enter the aneurismal pouch during the application of the compressing force. Thus, a slow, laminated deposit of fibrine occurs and the sac becomes hard and solid. When sufficient pressure is made upon the artery to close its calibre entirely, the anastomosing arteries, if the pressure is continuous, will soon carry a small blood-stream through the tumor, provided a branch leaves the main trunk between the seat of compression and the sac. The conditions are thus identical with those obtaining after Hunter's method of ligation; providing the occluding pressure is maintained without interruption for a sufficient number of hours and is not changed to a point below the origin of the branch through which the small reversed current is to enter the main trunk.

When the compression is only sufficient partially to close the arterial calibre, a small amount of blood necessarily enters the pouch by the ordinary route, and the therapeutic conditions are similar to those just described. When the complete compression is made so near the sac that no intervening branch exists all access of blood to the sac is stopped and

it becomes filled with soft clot. Cure must then result as in Anel's method of ligating, and with the same liability to failure from inflammatory reaction due to the pressure of the soft coagulum.

Fig. 105.

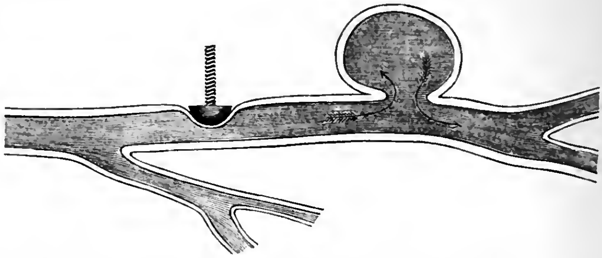


Diagram showing small amount of blood entering sac because pad of compressor does not entirely occlude the calibre of the artery.

It takes longer to fill the sac with deposits of laminated fibrine than with soft, homogeneous coagulum; but reasoning from what is seen after ligation I am inclined to recommend it as the surer and safer method. Therefore, that complete compression, as a rule, should not be employed unless the pressure can be applied far enough above the aneurism to insure the existence of an intervening branch which will carry a gentle current of blood through the sac, partial compression may be employed even near the aneurism because it allows a portion of the current to pass through the vessel at the seat of pressure and thus enter the sac.

By complete compression is not meant such a degree of force as will cause inflammation of the tunics and permanent occlusion of the artery; merely such pressure as will bring the opposite walls of the vessel in contact and prevent the passage of the blood current during the continuance of the pressure. This sort of compression should be continued for from four to ten hours, and usually requires anæsthesia during the whole period, for the prevention of discomfort and actual pain. When the aneurismal tumor appears to have become consolidated, which may occur in a short time, the pressure may be somewhat relaxed; but partial compression at least should be maintained for several hours longer. If this is not done, the sudden rush of blood may displace the fibrinous deposits in the sac; or, if the coagulum is merely soft, may cause its disintegration and thus destroy the prospects of cure.

Partial compression, which allows some blood to flow through the artery at the point of pressure, is more tolerable to the patient than complete compression, and, therefore, does not require anæsthesia. Narcotics may be demanded, however, to relieve distress occasioned by the restraint. This method of treatment must be continued for days, and perhaps for two or three weeks, because the blood current, though greatly diminished in volume, is sufficient to prevent rapid solidification in the sac.

Either form of compression may be employed continuously or interruptedly. Continuous compression is probably better than interrupted compression, whether complete or partial, because cure is more rapidly attained. It quite frequently happens, however, that treatment by either complete or partial compression requires so many hours or becomes so irksome to the patient, that it is necessary to suspend its employment from time to time. The intervals of non-treatment should be generally at

night, so that the patient may have every opportunity for obtaining rest and sleep. In the case of complete compression an intermission of several days is at times advisable. During the intermissions the patient should be kept perfectly quiet in bed. The sac is finally filled, if cure be effected, by successive layers of fibrine deposited during the periods of pressure.

The best method of compression probably is continuous complete compression applied far enough above the aneurism to insure the existence of an intervening branch to carry a little blood into the sac. If this form of treatment is not adaptable resort may be had to continuous partial compression.

After an aneurism has been cured by compression there is usually no obliteration of the artery found at the point of pressure. In the sacciform variety there is in some instances no obliteration even at the seat of the tumor, but the circulation goes on through a groove or channel in the solidified aneurism. Fusiform aneurisms are not very amenable to treatment by pressure.

Before compression is begun the patient should be confined to bed for three or four days, that he may become accustomed to the restraint and to urinating and defecating in the supine posture.

The limb should be shaved and washed, and the skin at the seat of proposed pressure sprinkled with chalk, oxide of zinc, soapstone, or other unirritating powder. The bed should have a firm mattress upon it. The intelligent coöperation of the patient should be obtained, for much depends upon the continuous perfect adjustment of the compressing force whether it be digital or instrumental.

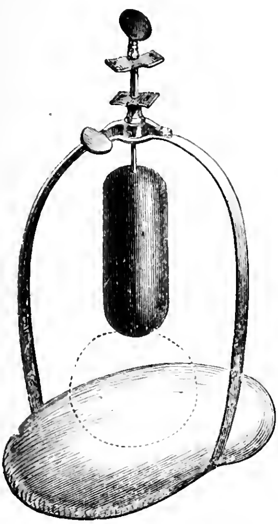
Bromide of potassium, chloral and morphia are often valuable agents for keeping the patient comfortable. When about to apply the compressing force the surgeon should, by momentary pressure on the distal portion of the artery, cause the sac to become well distended with blood. The finger or pad is then adjusted to the artery above the aneurism before the distal pressure is relaxed. Gentle compression of the tumor by an ordinary bandage applied up the limb during the time of treatment possibly conduces to hastening contraction of the sac. Inflammation of the skin or cellular tissue at the point of compression calls for temporary cessation of treatment.

The best compressing force is that exerted by the human finger. This is called digital compression, as opposed to instrumental compression, which is obtained by tourniquets, suspended weights, or similar apparatus. Digital compression necessitates relays of physicians or trained assistants, since one person cannot exert effective digital pressure continuously for more than ten or fifteen minutes. Two persons should be with the patient constantly. The first makes pressure on the artery with his thumbs placed one upon the other, while the second keeps his hand on the surface of the aneurism to see that absolute cessation of pulsation is maintained. When the first becomes tired of pressing, the second places his thumbs upon the vessel just above or just below the point compressed by his companion and controls the circulation before the latter relaxes his pressure. He that was the compressor now watches the tumor to see that pulsation does not return from inefficient arterial occlusion. Instead of using the muscular power of the second hand to reinforce the thumb placed over the artery, the compressor may have a bag of shot or a tourniquet so adjusted as to press upon the back of his thumb. This renders the operation less wearisome. Intelligent assistants are required for carrying out digital compression, since the pressure must be made in that direction

which will press the artery against the bone; and must not be made upon the vein if is possible to avoid it.

The femoral artery should be controlled by pressure below the groin directed backward against the head of the femur. The brachial artery at its upper part is compressed by pressure outward and backward against the shaft of the humerus. The amount of force should be no greater than that which stops pulsation in the tumor. It is for these reasons that the finger-tip of an intelligent person is far better than any pad that can be devised by instrument-makers. Complete occlusion can, therefore, generally be maintained without anæsthesia. Another, though indirect advantage of digital compression, is the constant presence of the assistants, which serves to interest and encourage the patient.

FIG. 106.



Watson's weight compressor. The dotted line indicates the position of the limb.

When trained assistants are not obtainable, digital has to be substituted by instrumental pressure. Sometimes one method may be used as an adjuvant to the other.

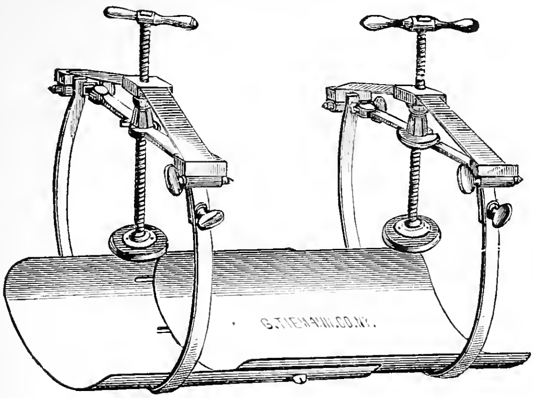
Various tourniquets and compressors have been devised for making pressure on the artery. The essential point is that the venous circulation shall be interfered with as little as possible; hence a small pad controlled by a screw or spring and a larger pad to make counter-pressure on the opposite side of the limb are characteristics of nearly all these instruments. Sometimes there are a series of small pads so that pressure can be applied alternately to different parts of the artery, and thus relieve the integument from injurious pressure. The same object can be obtained by using two single pad tourniquets placed a few inches apart, one of which can be relaxed while the other is screwed down upon the vessel.

These methods are objectionable when the varying points of pressure cause different anastomosing branches to carry on the collateral circulation, for too much blood may reach the sac in case ligation is required after failure to cure by compression. A single pad is probably preferable, supplemented, if necessary, by digital compression applied near the same spot. A conical weight or a bag of shot may be suspended or other means arranged so as to make arterial compression.

When the aneurism is of the brachial artery at the elbow, or of the popliteal artery, compression by flexion may be employed as a method of treatment. This mode consists in keeping the elbow or knee firmly flexed so as to bend the artery and at the same time exercise pressure on the tumor itself. The circulation through the sac is thus greatly lessened. The flexed posture can be maintained by applying a collar around the limb above the joint and another below it, and preventing extension by a short chain attached to both. A more simple means is an ordinary roller bandage applied by figure-eight turns. The forced flexion should be sufficient to check pulsation completely in the sac, but the joint should not be flexed to such an acute angle as will make too violent pressure on the aneurism or injure the articulation. It is not satisfactory in large

aneurisms, nor in those tending to inflammation. Rupture or suppuration may be induced by it in such cases. In small aneurisms and as an adjuvant to digital or instrumental compression, flexion has a value.

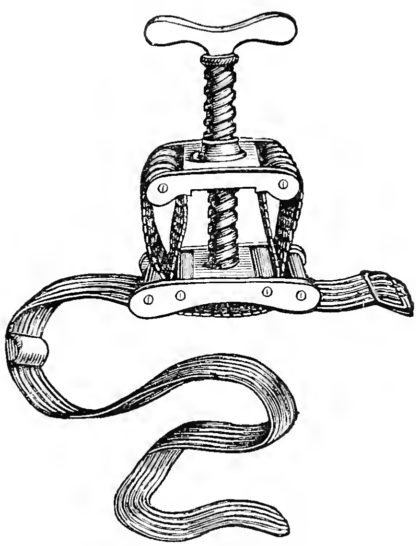
Fig. 107.



Briddon's compressor.

Cure of aneurism at the elbow or knee has occasionally been obtained by voluntary maintenance of the flexed position. So, indeed, has digital compression, of the interrupted kind exerted by the patient's own fingers, effected a cure of aneurism.

Fig. 108.



Signorini's tourniquet.

The last method of employing pressure is what may be called general compression, and is accomplished by the Esmarch apparatus. A rubber bandage is applied, as in preparing for amputation, from the distal ex-

tremity of the limb to the lower end of the aneurism. The surface of the aneurism is then left uncovered and another elastic bandage firmly applied above it, or the first bandage is carried loosely around the location of the tumor and applied tightly to the limb above. Near the trunk the application of the bandage is discontinued and the limb is encircled by the thick elastic band, which plays the part of a tourniquet. The access of blood to the limb is thus cut off and the other bandage or bandages are removed. The tumor, however, is left distended with fluid blood in a state of rest, which soon coagulates. It is perhaps well to delay a moment when the elastic bandage has been applied as far as the lower end of the aneurism, so that the current from above may fully distend the sac before the vessel is compressed on the proximal side of the tumor. The circulation should be kept out of the limb for about an hour, unless there is some contra-indication. Before the constricting cord is removed complete digital or instrumental pressure should be made upon the artery above it, lest the sudden current wash away or break up the soft, black clot in the sac. This, or moderate compression at least, should be kept up for a few hours afterward to allow the clot to become firmer. Anæsthesia will be required when the Esmarch apparatus is used.

FIG. 109.

Tufnell's truss-like compressor applied. (ERICHSEN.)

If the aneurism does not show absence of pulsation after this treatment, the patient should be let alone for a week before a second trial is made. In the meantime efforts to increase the coagulability of the blood may be carried on. These have been described under the medical treatment of aneurism. General compression seems to be most applicable to recent aneurisms of moderate size with walls that are not very thin. It is to be avoided or only applied with extreme caution and for short periods in patients whose vessels are markedly atheromatous. Danger of inducing gangrene is, under such circumstances, very great.

When ligation becomes necessary, after failure in curing by the Esmarch apparatus, the surgeon should not attempt to apply the ligature at the point where the constricting band encircled the limb. The peri-arterial structures are liable to be infiltrated or inflamed at this point. A higher or lower point should be selected. This rule should be followed in ligating after any form of compression has been previously employed.

The comparative advantages and disadvantages of compression in the treatment of aneurism claim attention. Though not without risk of inducing erysipelas, inflammation, and suppuration of the sac, thrombosis and gangrene, compression is safer than ligation. This is probably true, notwithstanding the fact that the use of catgut and similar aseptic ligatures has reduced very greatly the risks formerly associated with ligation. Partial compression has, however, the disadvantage of being a more tedious method than ligation, and is not available when the patient is fretful or the disease rapidly increasing. Neither form of compression is to be attempted when the limb is inflamed or œdematous. It is probable that the development of the collateral circulation due to the compression acts at times as a source of failure when subsequent ligation is demanded by inefficacy of compression as a means of cure. On the other hand, the same effect may be a preventative of gangrene after ligation, especially in the old, whose arteries are not well fitted to carry on the collateral circulation after ligation, unless previous gradual enlargement has been effected by compression.

Compression is not serviceable, as a rule, in the cure of fusiform aneurism.

The rules for employing compression then may be formulated as follows: Use it:

1. In aneurisms of recent development and when the success of subsequent ligation is not much imperilled by its use.
2. When ligation is especially dangerous, as it is in the aged, during epidemics of erysipelas, and in certain locations of the body.
3. Experimentally for five to seven days in nearly all cases.

If nothing is gained by compression in the course of a week, it is usually proper to resort to ligation.

Arterial ligation for the cure of aneurism has been practised in four ways, of which two are practically valueless. Of the two remaining methods one is always preferred, except when the proximity of the aneurism to the heart renders its performance exceedingly dangerous. This method is called the Hunterian method. It consists in applying a ligature to the artery between the aneurism and the heart, and at such a distance from the former as will insure the existence of a small branch leaving the artery between the ligature and the seat of disease. The ligature on being tied arrests at once the current in the main artery and would entirely stop the blood flow through the aneurismal sac, if the small branch mentioned did not exist. This small branch, which has an anastomosis with branches given off from the main vessel above the site of ligation, soon, by dilatation and reversal of current, carries a small amount of blood into the main vessel below its origin, and thence through the aneurismal sac. Thus, it is seen that the Hunterian method of ligation does not entirely arrest the current through the sac, but merely diminishes it very greatly, Deposition of laminated fibrine, which is the method of spontaneous cure which is most desirable, is thus determined, whereas entire arrest of the current would have caused the formation of soft clot

in the sac, which may, it is true, cause final solidification, but which is apt to be followed by inflammation of the sac.

FIG. 110.

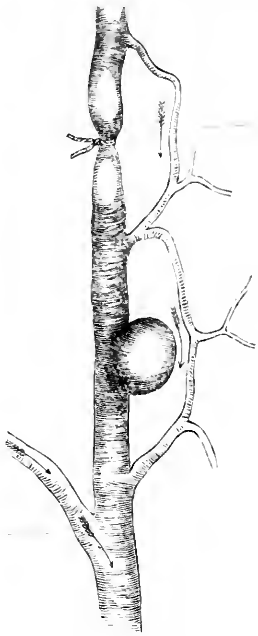


Diagram of anastomosis after Hunterian method of treating aneurism.

Of the three other methods of ligation one is a proximal ligation, that is, on the side of the disease nearer the heart, and two are distal ligations, that is, on the side away from the heart.

Table of the four methods of ligation in treating aneurism.

Proximal Ligations.

Anel's.—Ligature applied close above aneurism with no intervening branch.

Objections: 1. Difficult, because artery is overlapped or displaced by sac.

2. Causes total arrest of blood current, hence soft clot and tendency to inflammation of sac.

3. Artery probably atheromatous, hence tendency to secondary hemorrhage.

Hunter's.—Ligature applied at some distance above aneurism, so as to have an intervening branch.

Advantages: 1. Easy of performance.

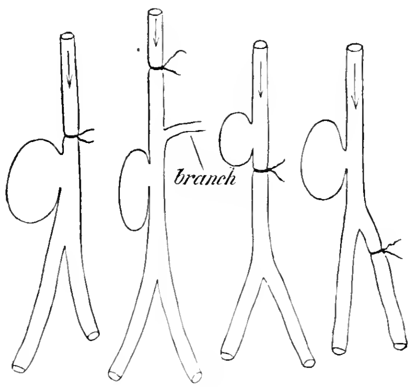
2. Causes partial arrest of blood current, hence firm fibrinous deposit.

3. Artery much more likely to be healthy.

Distal Ligations.

Brasdor's.—Ligature applied just below aneurism.
Objections: Same as in Anel's.
Wardrop's.—Ligature applied to trunk a little below first branch or to first branch a little below its origin from the trunk.
Advantages: Same in kind as those of Hunter's method, but it is less successful in causing solidification because current is not arrested sufficiently. Never used except in aneurism of innominate or of root of common carotid artery and then it is adopted because the Hunterian method is impossible.

FIG. 111.



Diagrams showing Anel, Hunter, Brasdor and Wardrop methods.

The Hunterian method of ligation must be considered more fully, since it is the one to be adopted when compression is deemed impracticable. The method of exposing the various arteries and ligating them in continuity is described in a subsequent section.

When the catgut cord has been placed under the vessel and before the knot is tied the artery should be compressed between the cord and a finger inserted into the wound, in order to prove by absolute arrest of pulsation in the tumor that the supplying artery has been exposed. Just before the ligature is drawn tight, it is well to make pressure for half a minute upon the artery on the distal side of the aneurism in order that the sac may be fully distended with blood before the circulation is arrested. A good size catgut or flat silk ligature is to be preferred. With ligation of the vessel, pulsation, thrill and murmur in the tumor immediately cease and the limb below shows some elevation of temperature, which usually, however, soon subsides.

Loss of muscular power, pain and hyperæsthesia are frequently observed in the parts below the site of operation. The tumor at first feels softer than usual, but in a few hours becomes harder and more elastic. This process of solidification continues and in a few days is completed by the transformatson of the sac into a hard ball. Contraction then begins and in the course of several weeks or months, nothing at all, or nothing

but a slight thickening, is perceptible to the touch. In rare instances some enlargement of the tumor without return of pulsation may occur after ligation from influx of blood from the distal part of the artery. This is apt to lead to the suspicion that a malignant muscular growth has been mistaken for an aneurism. A subsequent solidification of the sac clears up the doubt. A similar condition may follow compression.

After the operation the limb should be enveloped in cotton-wool held in position by a bandage loosely applied, and the patient should be directed to avoid attempting to move the extremity. Quiet should be obtained by anodynes, if necessary. The cotton tends to preserve an even temperature, and protects from injurious influences the parts which have now a diminished circulatory supply. For a long time, even after consolidation of the tumor, all violent exercise of the extremities should be avoided. Impairment of muscular power, liability to suffer from exposure to cold, and other nutritive defects often remain permanently after arterial ligation for any cause.

The Hunterian method of ligation is usually followed by the development of two collateral circulatory arches: one between the branches above the ligature and those given off between it and the aneurism, and another between the branches below the aneurism and those above it. The lower anastomosis—namely, that around the aneurism, is generally established more rapidly than that around the ligature, because the collateral branches in the former region have previously been enlarged by the circulatory interference occasioned by the pressure of the aneurismal tumor. This double anastomosis is due to the fact, that the artery usually becomes obliterated at the seat of aneurism as well as at the seat of ligation, but is pervious between those points. If the sac solidifies and leaves the vessel pervious opposite the seat of aneurism, or if the vessel becomes entirely occluded by clot or obliterated from the ligature to a point below the aneurism, only one collateral arch is developed.

Ligation is indicated for the treatment of aneurism:

1. When compression has been tried unsuccessfully and when compression cannot be applied; provided that the disease is advancing and so located that the application of the ligature is not attended with unusual risk.

2. When the aneurism has ruptured and caused hemorrhage into an articulation or into the intermuscular spaces; provided that the condition does not demand amputation.

3. When rupture into one of the cavities of the body or upon the surface, or the possibility of an early occurrence of such rupture threatens to destroy life by hemorrhage.

Ligation is contra-indicated:

1. When the locality of the aneurism is such that compression can be applied.

2. When the operation is peculiarly dangerous on account of the location of the aneurism, the existence in the patient of extensive arterial or cardiac disease, or the prevalence of erysipelas or pyæmia.

3. When, on account of the proximity of large anastomosing branches or from any other circumstances, the operation would probably be unsuccessful. Under such circumstances ligation is justified only by impending rupture.

The complications likely to arise after ligation, which may interfere with the successful solidification of the aneurism or tend to destroy the patient's life, are: recurrent pulsation in the tumor, secondary hemor-

rhage at the site of operation, suppurative and gangrenous inflammation of the sac, gangrene of the extremity, pyæmia, and in special locations, secondary disease of the brain or thoracic viscera.

Recurrent pulsation is due to the anastomotic arch around the ligature allowing too free a blood-current to enter the artery between the ligature and the aneurism. An anomalous distribution of the branches or abnormally large size of the usual branches, is the cause of this undesirable freedom of the collateral current. The employment of the compression treatment for a considerable period previous to resort to ligation, is at times an agent in developing unusually free anastomosis. Recurrent pulsation develops within twenty-four hours, and, if slight, is not likely to interfere with progressive consolidation of the tumor. If it increases in force in the succeeding few days and the tumor remains soft and without diminution in size or shows evidence of enlargement, the operation is proved to have been unsuccessful, and other means of cure must soon be adopted. Recurrence of pulsation after the lapse of several months is almost certainly due to the development of a new aneurism, near the site of the cured aneurism.

Recurrent pulsation should be treated by elevation of the limb and moderate compression of the tumor and of the artery above the site of ligation, success will probably follow; if not, continued progress of the disease will demand Anel's method of ligation, incision of the sac and double ligature, or amputation.

Secondary hemorrhage may, after the lapse of one or two weeks, occur from the wound made at the time of ligation. This is due sometimes to an atheromatous condition of the artery preventing proper healing of the vascular coats divided by the ligature. At other times, it is caused by a large branch being given off so near the site of ligation that the collateral current coming through it into the main trunk exerts too much pressure for successful resistance by the short internal clot.

Secondary hemorrhage is more frequent in the upper than in the lower extremity, because the anastomosis is more free. As rapidity of union of the wound is a barrier to secondary hemorrhage, strict asepsis and antisepsis have made secondary hemorrhage very uncommon after ligation for aneurism. The flat ligature of animal nerve or tendon, which merely approximates the arterial walls without dividing the internal and middle coats, will probably be found by future experiment to be the safest means of ligating atheromatous vessels.

When secondary hemorrhage occurs, it should be treated by pressure made upon and in the wound by compression with plugs of sponge, or fine shot. If this fails the Esmarch apparatus should be applied, the wound opened freely and the artery ligated above and below the former ligature. In the event of the bleeding still continuing ligation of the artery in continuity at a higher point is good practice in the upper extremity, but is very likely to be followed by gangrene if done in the lower extremity, where the establishment of sufficient collateral circulation is unusual. Amputation is, therefore, usually preferable in persistent secondary hemorrhage occurring after ligation for aneurism of the leg or thigh. If the second ligation in continuity is done in either extremity, such a point must be selected as will permit subsequent amputation if this becomes necessary. Occasionally it is possible to control secondary hemorrhage by ligating in continuity the branch through which the blood finds its way into the distal portion of the trunk originally tied.

Suppurative or gangrenous inflammation of the sac may result from

recurrent pulsation, from incomplete anastomosis around the aneurism, from complete arrest of circulation in the sac and consequent formation of soft clot, from the great size and thinned walls of the sac, and from external violence, such as may be sustained by rough handling or kneading of the tumor either before or after ligation. The symptoms of inflammation of the sac are those characteristic of a similar process elsewhere. Suppuration is exhibited by the ordinary signs of abscess. When an opening has occurred spontaneously or by incision, hemorrhage becomes a prominent symptom. If recurrent pulsation has existed, the bleeding will be immediate and profuse; under other circumstances the escape of blood may not occur for several days, and at first will probably seem insignificant. Suppuration or sloughing occurring even so late as six or eight weeks after ligation may, especially if accompanied by recurrent pulsation, be followed by fatal hemorrhage.

Suppuration of the sac is to be treated by at once applying a provisional tourniquet to the artery above the seat of ligation and laying open the abscess. If bleeding occurs the surgeon should proceed to turn out the clot, securing dangerous points by ligature or the actual cautery, make the wound antiseptic, pack it, and wait for it to heal by granulation. Sponge grafting would probably hasten cicatrization by causing granulations to fill the cavity more promptly. The patient must be constantly watched by competent surgical attendants, so that on the first sign of bleeding the artery can be controlled by digital compression, or by screwing down the pad of the tourniquet, which is kept loosely applied. If hemorrhage persists, amputation should not be long delayed by experiments with temporizing measures.

Gangrene of the limb is a formidable complication of ligation. Its occurrence may be due to rigidity of the arterial branches preventing sufficient enlargement for the establishment of collateral circulation, to pressure of the tumor upon the anastomosing branches, to injury of the main venous trunk at the time of ligating the artery, and to exposure of the limb to heat, cold, or undue pressure soon after the operation. This complication arises within the first week or ten days, and is more frequent in the lower than in the upper extremity. The form is generally that of moist gangrene because venous obstruction is usually one of the factors in its etiology. Wrapping the limb in cotton to keep the temperature equable and to avoid injury, and slightly elevating it to encourage venous return are measures calculated to lessen the probability of gangrene. Gentle friction of the limb toward the body may sometimes be used to accelerate the venous blood current. When gangrene has begun after arterial ligation, but little can be done except promptly to amputate the limb high up. In the upper extremity removal at the shoulder-joint, in the lower removal at the junction of the middle and upper thirds of the thigh will probably be necessary. Occasionally laying open the sac and turning out all clots will relieve venous obstruction and restrain the progress of gangrene.

Gangrene of a similar character may follow the employment of compression for the cure of aneurism.

Pyæmia may follow ligation, and is more frequent in patients who have previously suffered from hemorrhage or other depressing influences. Finally ligations of vessels near the body may be complicated with pleurisy, peritionitis, and other unfortunate sequences, due to injury at the time of operation, or to spreading of inflammation. The fatal issue after

ligation of the common carotid artery may be due to cerebral anæmia or thrombosis.

Suppuration and septicæmic or sapræmic processes occurring in connection with aneurism are, of course, due to the same vegetable parasites as cause these conditions in other surgical wounds or diseases. The bacteria either gain access by the wound made, or while circulating in the blood or lymph streams, are arrested and find a place of least resistance in the tissues where the aneurism exists.

Ligation of Arterial Trunks in Continuity.

Arteries are tied in their continuity to lessen the circulation through aneurismal tumors and to arrest secondary hemorrhage, which pressure or ligation in the wound has failed to control. The special instruments required for the operation are a bistoury or scalpel, dissecting forceps, a grooved director, two metallic retractors with which to hold the margins of the incision apart, an aneurism needle, and a strong antiseptic ligature of catgut, ox-tendon, or nerve.

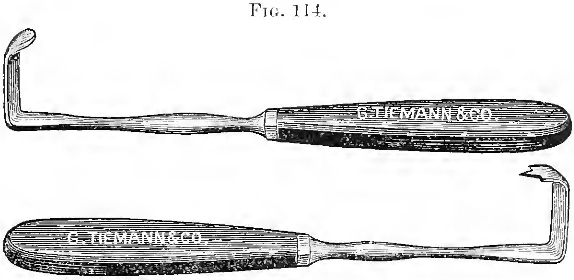
Fig 112.

Grooved director.

Fig. 113.

Aneurism needle.

Fig. 114.



Blunt and sharp-pointed retractors.

The surgeon must first of all determine the exact course of the artery by the well-known landmarks of clinical anatomy and the linear guides which are based upon these relations. If the artery is a superficial one its pulsation will aid in this determination. If a superficial tendon or muscle is one of the guides, it can be made to stand out prominently by getting the patient, before etherization, to use it voluntarily. The line of the tendon or artery can then be marked on the skin with a moistened aniline pencil. In operating on the dead body such tendons are made prominent by moving the joints in such a manner as to bring tension on

the muscular fibres. For example, if a flexor is the guide ask the patient to *flex* the joint, and the muscle will on contraction become prominent; but in the surgical laboratory the same muscle in the cadaver can only be rendered prominent by forcibly *extending* the joint.

The second step is to decide upon the point of ligation. In secondary hemorrhage it is the best, if practicable, to expose and tie the vessel near the wound and on both sides of it. In the case of aneurism the Hunterian method is usually the best. This places the ligature sufficiently far from the aneurism to insure at least one *small* branch being given off by the trunk between the site of ligation and the aneurism. The ligature should always be applied at least one-half or three-quarters of an inch below the origin of any large branch or bifurcation of the artery. When this is anatomically impossible it is often wise to secure the branch also with a ligature to prevent secondary hemorrhage, which otherwise may result from the forcible collateral current developed in the branch or bifurcation.

The incision in most instances should be made slightly oblique to the course of the artery and with its centre over the point chosen for ligation. Such an obliquity of ten degrees makes it much more easy to search for the muscular interspaces and other deep guides leading to the vessel. The skin should be steadied, but not displaced, by the thumb and fingers of the left hand while the point of the knife is inserted perpendicularly through the skin and an incision varying from two to five inches in length is made with one sweep. The scalpel should be brought out perpendicularly in order that the wound may be of one depth throughout its entire length. The incision should always be sufficiently long to afford free access to the tissues beneath. When the artery is deeply located, whether from its anatomical relations or the obesity of the patient, a long incision is demanded. The superficial fascia may be divided at the same time as the skin, if the vessel lies below the deep fascia. Large superficial veins should be drawn aside, if convenient, though their division is of little importance since the bleeding is easily arrested by hemostatic forceps or ligatures if it does not cease spontaneously. The deep fascia is to be incised in a similar manner as the skin, or it may be punctured and a grooved director slipped under it, after which manœuvre it is divided by carrying the inverted knife along the groove. The original length of the incision should be maintained until the sheath of the artery is reached. If the deep fascia is so tense as to prevent satisfactory investigation of the parts beneath, a short incision may be made across the middle of the longitudinal one.

Muscular interspaces are guides to some of the arteries. These, on account of the fat deposited in them, are usually quite readily recognized as yellow lines. Sometimes this yellow appearance is seen before the deep fascia is divided. Another guide to them is furnished by the small vessels which ramify in them and perforate the fascia covering them. The proper muscular interspaces to gain access to the artery are next torn open with the rounded end of the director; or the wound is deepened by the careful use of the scalpel. As the situation of the artery is approached the forceps and the back of the scalpel's point are the safest means of separating the tissues. During this dissection the wound may be held open by blunt hooks or retractors, and the bulging muscles relaxed by bending the joints.

The larger arteries, with the accompanying vein or veins, are enclosed in a distinct fibrous sheath. This sheath is to be opened by pinching up

a fold with small toothed forceps and making in it with the knife a cut about a quarter of an inch long. While the forceps holds the edge of the opening the end of the grooved director or aneurism needle is introduced into the sheath on one side of the artery and used to break up the adhesions between the vessel and the sheath, or the adjacent contents of the sheath. By a similar manœuvre on the other side of the vessel complete isolation of the same is accomplished. Isolation of smaller arteries which have no distinct sheath can be readily performed by using two pairs of forceps to pull away the small veins and cellular tissue. The use of the point of the knife is dangerous in cleaning the artery, lest a puncture be inflicted upon the artery or vein. Care must be observed with the blunt instruments that undue bruising is not done.

The Esmarch apparatus is sometimes applied to prevent obscuration of the parts by hemorrhage during the operation. Usually it is unnecessary, for only a few small branches are divided. These can be tied, if necessary.

It is well to remember the characteristics of an artery in the living subject. It has a pinkish-white, smooth, shining surface, and is compressible, feeling as it is rolled under the finger-tips as if two surfaces were slipping upon each other. A nerve has not this smooth, shining surface, but has longitudinal markings, due to its fibrous structure, and rolls under the fingers as a solid non-compressible cord. A vein is purplish, soft, and flaccid, and from its distention with dark blood resembles a leech in appearance. It becomes more distended if pressure is made on its cardiac end. A small tendon is pearly white and glistening, and gives, when seized, the impression of great density. Passive motion of the neighboring joint may prove its identity. The recognition of the artery is often aided by its location between two satellite veins and by its pulsation. Pulsation, however, may be absent, because exposure and manipulation sometimes cause arteries to contract and become temporarily pulseless. On the other hand, a deceptive pulsation may be transmitted to nervous or fascial bands lying over an artery. When the operator fails to find the artery he should not tear up the tissue in an aimless manner, but should at once review all the steps of the operation and systematically verify each landmark from the surface downward. In this way he will discover the source of error.

After the artery has been recognized and isolated the end of the curved aneurism needle, threaded with antiseptic catgut or silk is carefully passed around it without disturbing its surroundings or pulling it from its bed. Chromicized gut is better for large vessels than plain gut since it is not so quickly absorbed. This is best done by grasping the tissues at one side of the artery, but not the artery itself, with the forceps and insinuating the aneurism needle with a curvilinear movement under the artery from that side. A little lateral movement of the point of the needle will render its passage more easy. As the point projects at the opposite side of the vessel the tissue overlying it may be torn through with the finger-nail or forceps, if it is seen not to be a vein or part of the arterial wall. When the loop of ligature in the eye of the needle is visible it is drawn out of the wound by the forceps while the needle is made to retrace its course under the vessel and is thus removed.

If the artery has a single vein alongside of it the needle should be introduced at the venous side, of the artery, since puncture of the thin-walled veins is thus less likely to occur than when the point of the needle is carried beneath the vessel from the side opposite to the vein. If accompanying veins exist on both sides of the artery this precaution loses its

value. If by accident such a large vein is punctured during the operation, it may be well to extend the incision and tie at a higher point of the artery. Bleeding from the vein is to be controlled by lateral ligation or suture of the vein, if any venous hemorrhage of importance occurs. Before tying the ligature the surgeon should hold the artery in the loop of the string and compress it with a finger to be sure that pulsation below is arrested by constriction of the structure encircled. This manœuvre proves

Fig. 115.

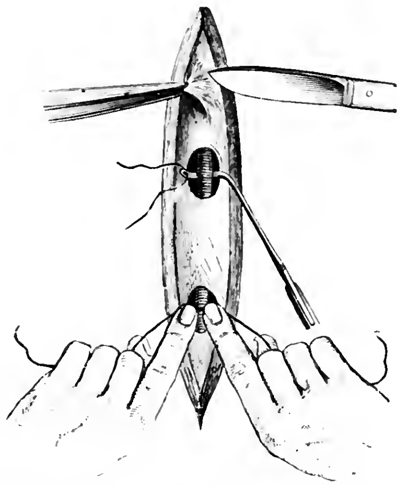


Diagram of opening sheath of artery, passing ligature and tying ligature. (Bryant.)

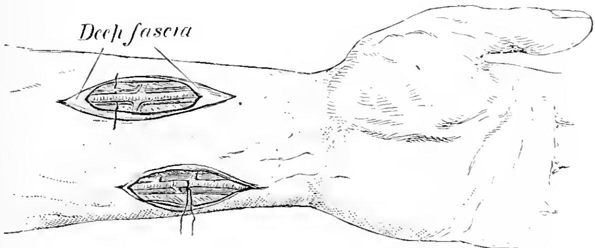
or disproves the proper application of the ligature, which may be around the wrong artery or perchance around a nerve or piece of fascia. The ligature should be secured by a friction knot or a flat knot; and in the latter case it is well to tie the ends a third time after completing the ordinary double tie, for the catgut is apt to become loosened. During the knotting the index fingers should be carried into the depth of the wound in order not to raise the vessel from its bed. Sufficient tension should be put upon the first tie to insure division of the inner and middle coats of the artery. This is known by the sensation of cutting into the wall that is felt by the operator as the noose is tightened. When mere approximation of the inner tissue is desired, this cutting is avoided by using flat ligatures of ox aorta or nerve. After ligation is accomplished the wound is approximated with sutures, cotton is applied around the limb to maintain an equable temperature, and the extremity is slightly raised to encourage venous return. The wound must be kept bacteria-free so that septic and purulent infection may be with certainty avoided.

Ligations of Special Arteries.

Certain of the arteries are ligated in continuity with comparative frequency. The most eligible site for such ligations must be mentioned and the successive steps described. The unusual operations will be omitted.

Radial and Ulnar Arteries.—These vessels are seldom tied, except at the wrist. If deligation at a higher point of either artery is demanded, the surgeon usually prefers to secure the brachial. The radial artery above the wrist lies between the tendons of the radial flexor of the carpus and the long supinator, immediately below the deep fascia and upon the square pronator. Its direction and site are indicated by a line drawn from the middle of the bend of the elbow to the inner side of the styloid process of the radius. An incision one and a half to two inches in length midway between and parallel to the radial flexor and the long supinator will expose the vessel with its satellite veins. The deep fascia must be divided with care or the artery may be wounded. The pulsation of the artery is readily felt before the skin is incised.

Fig. 116.



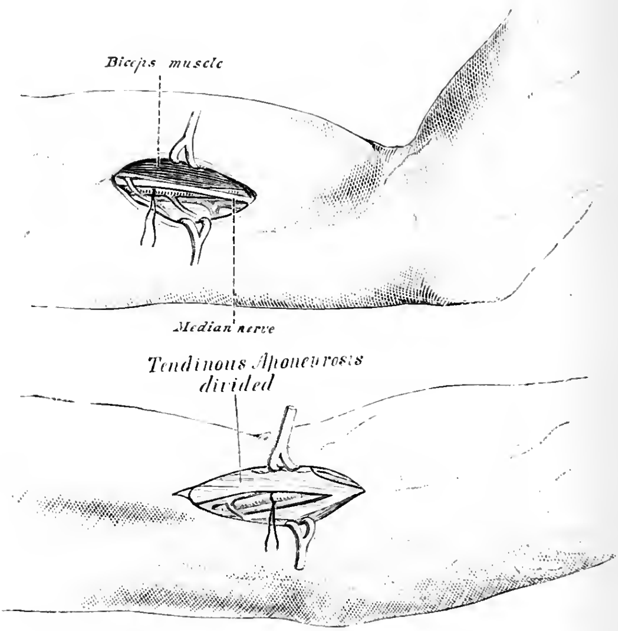
Ligation of radial and ulnar artery. (Bryant.)

The ulnar artery at the wrist lies under the radial border of the tendon of the ulnar flexor of the carpus and between it and the superficial flexor of the fingers. The vessel lies under a layer of fascia situated below the tendon; hence, it is necessary to divide two layers of deep fascia before reaching it. The ulnar nerve is situated at the ulnar side of the artery and close to it. The course of the lower portion of this artery is indicated by a line drawn from the inner condyle of the humerus to the radial side of the pisiform bone. The surgeon may depend upon this line for determining his incision, or may recognize the position of the tendon of the ulnar flexor of the carpus by its insertion into the pisiform bone, and make an incision of one and a half or two inches along its radial margin. The glistening tendon, uncovered after dividing the deep fascia, should be drawn from the middle line of the arm, when the second process of deep fascia will be exposed. This must be opened before the artery is reached unless it has an anomalous course above the fascia. It is usual to pass the aneurism needle first between the artery and the nerve.

Brachial Artery.—The brachial artery in the middle of the arm lies along the inner border of the biceps; and upon the coraco-brachial, the anterior-brachial muscles, and the inner head of the triceps. The median nerve passes over it, though occasionally under it, from without inward. A satellite vein is to be seen on each side of the vessel, and the large basilic vein not far distant internally. A line, drawn from the junction of the anterior and middle thirds of the axilla to the middle of the bend of the elbow, indicates its course with accuracy. Its pulsation is easily felt. An incision two and one-half or three inches in length is to be made along the inner side of the biceps; when the deep fascia has been divided, the muscular fibres of its margin will be fully exposed. Alongside of or under the edge of this muscle will be seen the median

nerve, which is then drawn aside to reveal the artery lying beneath it. The nerve often shows marked transmitted pulsation. Sometimes the artery is more superficial than the nerve. The arm should at this stage be flexed at the elbow to relax the belly of the biceps. It is usually better to have an assistant hold the arm than to allow it to lie upon the table, because such pressure displaces the artery and pushes up the triceps, which may be mistaken for the biceps. The edge of the biceps should always be uncovered and identified; if it is not, the surgeon may work too far inward and backward and become confused by mistaking the ulnar nerve for the median, and the basilic vein for the artery. The vessel is to be sought at or under the edge of the biceps in an outward rather than an inward direction.

Fig. 117.



Ligation of brachial artery. (Bryant.)

Since the brachial artery is not infrequently double or perhaps bifurcates into the radial and ulnar up near the axilla, it is important that the surgeon remember this possible anomaly, and ascertain that he has secured that vessel which will diminish the blood-supply as he desires.

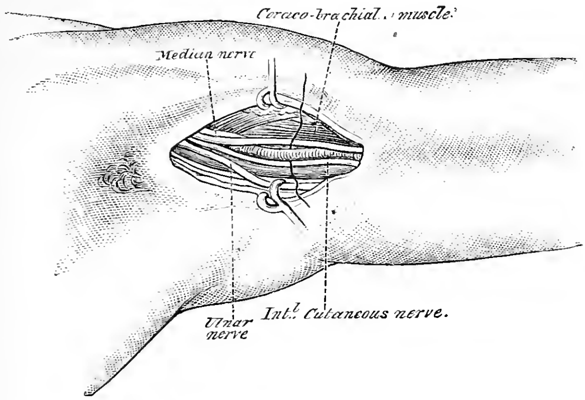
Axillary Artery.—The third portion of this vessel can be reached with safety and ease. If ligation at a higher point is demanded by the exigencies of the disease, it is better perhaps to secure the third portion of the subclavian than to attempt ligating the first or second portion of the axillary.

The last, or third portion of the axillary artery, beginning at the lower edge of the lesser pectoral muscle, lies along the inner border of the coraco-brachial muscle. The median and musculo-cutaneous nerves lie on the outer side of the artery; the ulnar and internal cutaneous nerves and the axillary vein on the inner side. Sometimes there is a satellite

vein on each side of the artery instead of the single large axillary vein on its inner side, which is replaced by the continuance upward of the basilic vein.

A line drawn from the junction of the anterior and middle third of the axillary fossa to the middle of the bend of the elbow, gives the course of this portion of the axillary and the greater portion of the brachial artery.

FIG. 118.



Ligation of axillary artery. (BRYANT.)

When the arm is placed at a right angle with the body the muscular margins of the axillary pit are prominently shown. With the limb in this position an incision three or three and one-half inches long should be made parallel to the anterior boundary of the axilla, and about one third the width of the axillary space behind this boundary; or, in other words, directly over the head of the humerus and a little oblique to the line given above. The edge of the coraco-brachial muscle will be exposed. From this the operator searches in an inward direction, finding, first the median and perhaps the musculo-cutaneous nerves, and then the artery, with the axillary vein, the ulnar and internal cutaneous nerves on the inner side.

The nerves, which vary somewhat in their relations, may be mistaken for the artery. Occasionally a muscular slip from the broad dorsal muscle crosses the artery. It is recognized by the transverse direction of its fibres. The ligature must be passed from within outward, and should not be applied near the origin of the subscapular artery.

SUBCLAVIAN ARTERY.—The third portion of this artery extends from the outer margin of the anterior scalene muscle to the outer or lower border of the first rib, and is the only part of the vessel that can be ligated with comparative safety. It is situated in the triangle bounded by the clavicle and the sterno-mastoid and omo-hyoid muscles; lying against the first rib, the anterior scalene muscle and brachial plexus of nerves. The subclavian vein is situated below and in front of the artery, from which it is separated by the insertion of the anterior scalene muscle into the tubercle of the first rib.

To ligate the artery in its third position proceed as follows: Depress the patient's shoulder, turn his head in the opposite direction, and draw the skin of the supraclavicular fossa downward upon the clavicle with

the left hand and hold it there. Then make an incision, three or four inches in length, upon the clavicle and following its curves, beginning a half inch from the sterno-clavicular joint. The tissues should be divided down to the periosteum. When the left hand has released its traction, the skin will slide upward and the incision will be located about half an inch above the clavicle. This manipulation of the skin preserves the external jugular vein from division by the incision. The wound should now be deepened by dividing the deep fascia and cutting the edges of the sterno-mastoid and trapezius muscles, if they prevent the wound being continued deeper with its original length. The fibres of the platysma myoid muscle in the superficial fascia will be noticed during the dissection. If the external jugular vein cannot be held out of the way with a hook, it is to be divided. A ligature should be placed also at the cardiac side of the proposed section before the division is made, lest air be sucked into the heart. As the wound is carefully deepened the surgeon's finger seeks, at its inner corner, the edge of the anterior scalene muscle as it goes down to its insertion into the first rib. The tubercle of insertion is often poorly developed, but the direction of the fibres, and possibly the exposure of the phrenic nerve running obliquely over the muscle, will serve to differentiate it from other structures.

Fig. 119.

Ligation of subclavian artery. (Bryant.)

If the omo-hyoid muscle or brachial plexus is recognized before the anterior scalene is seen, the search should be made in a direction downward and inward from those landmarks. The artery is finally uncovered beyond the outer border of the anterior scalene by opening with the forceps or director a layer of fascia extending over the vessel from this muscle. The artery lies at a depth of from one to three inches from the surface and runs in a downward and outward direction almost in the axis of the arm. The aneurism needle should be passed from above downward, because there is more danger of encircling the nearest cord of the brachial plexus than of injuring the vein which lies at some distance from the artery, though below it. This is an exception to the axiom which

directs the needle to be passed, as a rule, first between the vein and the artery about to be ligated.

The chief errors to be avoided in the operation are injury to the veins and ligature of that portion of the brachial plexus. During the dissection the suprascapular artery or the transverse artery of the neck may be divided and require ligation.

Common Carotid Artery.—The direction of the common carotid and its continuation, the internal carotid artery, corresponds with a line drawn from the sterno-clavicular joint to the tragus of the ear. The common carotid artery extends only to the level of the top of the larynx, where it bifurcates into the external and internal carotid arteries. The left carotid has its origin lower than the sterno-clavicular articulation. but in this intrathoracal portion of the artery surgeons have little interest. This circumstance, however, renders ligation of the carotid below the omo-hyoid muscle safer on the left than on the right side; because the ligature is further from the blood stream in the parent vessel. The external carotid at its origin lies from a quarter to a half inch *nearer* the middle line of the neck than the line given for the internal carotid.

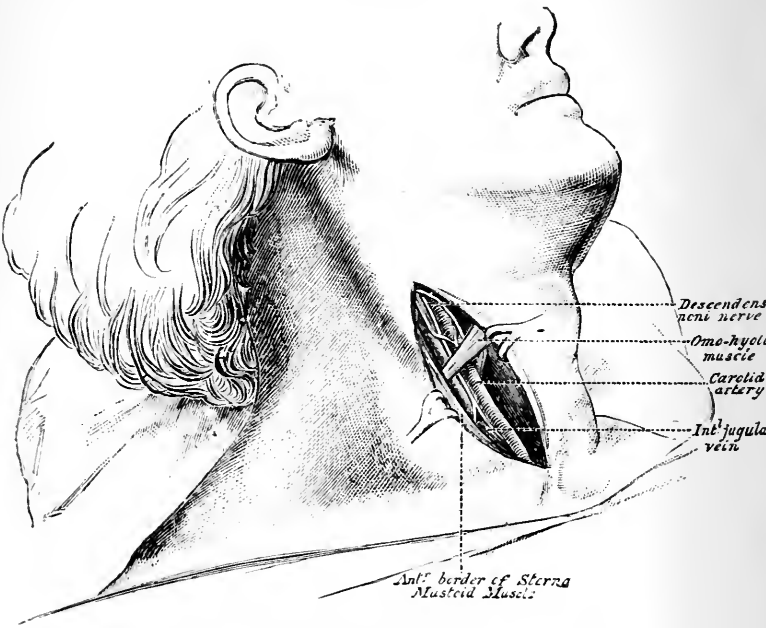
The common carotid artery lies beneath the anterior edge of the sterno-mastoid muscle in a sheath, which also encloses the internal jugular vein and the pneumogastric nerve. The vein lies on the outer side of the artery, the nerve lies behind both and in the groove between them. The descending branch of the hypoglossal nerve forms a loop with branches from the cervical plexus usually upon the front of, but sometimes within, the sheath. The artery becomes more and more superficial as it ascends. Its sheath is crossed by the omo-hyoid muscle about midway between the sterno-clavicular joint and the top of the larynx; or, in other words, at the level of the cricoid cartilage.

For ligation of the common carotid the patient's head should be thrown well back, with the chin turned toward the opposite side. A small pillow or roll of cloth under the nape of the neck enables the surgeon to keep the patient in this posture. An incision of two and a half or three inches with its centre corresponding to the level of the cricoid cartilage should be made along the anterior edge of the sterno-mastoid muscle. When the fascia and the platysma-myoid muscles have been divided and the fibres of the sterno-mastoid become visible by the dissection, the margin of the latter muscle must be turned outward and the angle between it and the omo-hyoid muscle, with its obliquely ascending fibres, found. If the omo-hyoid is pulled inward and the sterno-mastoid outward, the sheath of the artery, with very possibly the descending branch of the hypoglossal nerve upon it, will be seen. The sheath will also be recognized by its slipping sideways between the finger and the vertebræ behind, and by the pulsating vessel within it. The external and anterior jugular veins should be drawn aside, if in the line of the dissection. When this cannot be done, they may be tied and divided. The sheath is then opened toward the tracheal side of the artery, which is isolated with care, and the needle passed from without inward, in order to avoid injury to the internal jugular vein lying on the outer side of the artery. This operation ties the common carotid artery just above the omo-hyoid muscle, which is the better situation for application of a ligature.

To ligate below the omo-hyoid, make a three-inch long incision just in front of the anterior margin of the lower third of the sterno-mastoid muscle. Detach the inner portion of the muscle from the clavicle and turn it outward. The omo-hyoid and the sterno-hyoid muscles will thus

be exposed. These are to be pulled apart by hooks, when between and below them will be seen bulging upward the sterno-thyroid muscle. The finger thrust down between the lower part of the omo-hyoid and the sterno-thyroid, which is on a lower plane, will feel the artery beating in its sheath.

Fig. 120.



Ligation of the common carotid artery. (Bryant.)

It may be necessary to incise the sterno-thyroid in order to expose fully the sheath, which is then opened and the aneurism needle passed around the artery from without inward. In both operations the branch of the hypoglossal nerve should be protected from injury as much as possible.

Internal and External Carotid Arteries.—The common carotid artery should not be tied for a lesion of the external carotid or its branches when there is room between the bifurcation of the common trunk and the lesion to allow the safe application of a ligature to the external carotid. Ligation of the internal carotid should be performed in many conditions which formerly have been treated by tying the common carotid trunk.[1]

For ligating the internal carotid an incision two and a half inches long with its centre about half an inch above the upper border of the larynx, should be made a little oblique to a line drawn from the sterno-clavicular joint to the tragus of the ear. The vessel will be found along the edge of the sterno-mastoid muscle. The hypoglossal nerve crosses the vessel about an inch above its origin, and the descending branch of the same nerve will probably be found running down the artery. The hypoglossal nerve

[1] See Dr. John A. Wyeth's Prize Essay on this subject. Trans. American Med. Association, 1878.

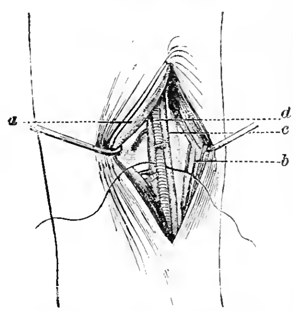
and the digastric muscle, which also crosses the artery, should be drawn upward and the ligature passed from without inward, avoiding constriction of the internal jugular vein and the pneumogastric nerve on the outer side, the external carotid on the inner side and the hypoglossal nerve superficially.

The external carotid, which also is crossed by the hypoglossal nerve and digastric muscle, may be tied by a similar incision, but it must be remembered that this artery is placed a little *nearer* the middle line of the neck than the internal carotid.

If a large branch is given off near the point of ligation, it also should be tied.

Anterior Tibial Artery.—A line drawn down the front of the leg from the inner side of the head of the fibula to a point midway between the two malleolar prominences marks the direction of the anterior tibial artery. The vessel, throughout its course, lies along the outer margin of the anterior tibial muscle. It is deeply placed upon the front of the interosseous membrane, at its upper part; but it gradually becomes superficial as it descends to the ankle, where it is found immediately under the deep fascia. It can be quite readily tied in its middle third by an incision, three inches long, made a little obliquely to the line given above. The operator, before incising the deep fascia, can usually define the intermuscular space bounding the outer border of the anterior tibial muscle, by a yellowish-white line of fat showing through the deep fascia. The deep fascia should be divided just as the skin and superficial fascia have been; after which the space between the anterior tibial muscle and the long extensor of the toes should be torn open with the finger or end of the grooved director. This procedure will expose a third muscle, the extensor of the great toe, lying between the two just mentioned and at a lower level. Search in the bottom of the fissure between this extensor of the great toe and the anterior tibial muscle will reveal the artery, with the anterior tibial nerve lying to the outer side or a little in front. It is possible that the extensor of the great toe may have its origin from the fibula lower than usual, then the vessel will be found in the same manner, but between the anterior tibial muscle and the long extensor of the toes.

Fig. 121.



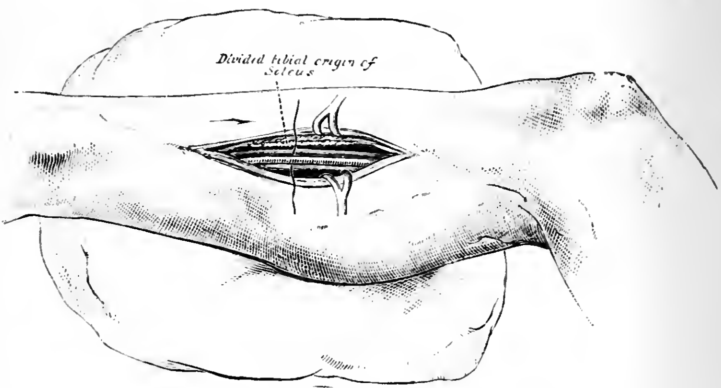
Ligation of anterior tibial artery. (Smith.)

The operator must remember to keep close to the outer margin of the anterior tibial muscle. If he mistakes the proper intermuscular space he will fail to reach the vessel. Passive motion of the great toe, of the smaller toes, and of the ankle joint will enable him to distinguish the various muscular bellies in the wound.

Posterior Tibial Artery.—The course of this artery is indicated by a line drawn from the middle of the popliteal space to a point midway between the tip of the inner malleolus and the anterior border of the tendon of Achilles. The vessel, when it gets behind the inner malleolus curves forward and goes to the sole of the foot. Behind the malleolus it is covered only by the skin and the superficial and deep fascias. The deep fascia is very thick because of fibres prolonged from the lateral ligament of the ankle-joint. Ligation of the artery at this point is readily

effected by a crescentic incision of two inches in length, situated half an inch behind the malleolus, with its concavity toward that bony projection. A single large nerve, the posterior tibial, is usually found on the posterior or heel side of the artery; sometimes there are two small nerves, one on each side. The tendons of the posterior tibial muscle and long flexor of the toes lie in front of the artery—that is, nearer the malleolus; the tendon of the long flexor of the great toe behind it and deeper. Occasionally the artery bifurcates into the two plantar arteries before reaching the sole; in such a case the two vessels may be tied.

FIG. 122.



Ligation of posterior tibial artery. (BRYANT.)

In the middle of the leg the posterio-tibial artery lies beneath the gastrocnemius and soleus muscles and upon the posterior tibial muscle and the long flexor of the toes. It is separated from the soleus by a septum of the deep fascia and has the posterior tibial nerve lying on the outer or fibula side. The artery can be ligated from the side of the calf as follows: Lay the leg on its outer aspect with the knee flexed and the heel raised to relax the calf muscles. Make an incision of four or five inches, parallel to and half an inch behind the inner margin of the tibia. If the gastrocnemius is seen, draw it away from the tibia and expose the soleus; if it is not seen, the soleus will be exposed at once. The soleus is then to be cut from its attachment to the tibia by carrying the knife, with its edge directed *against* the bone, along the entire length of the cutaneous incision. By drawing the cut muscle outward the surgeon will uncover the septum of deep fascia that lies over the artery. The vessel can be seen or felt beneath this fascia about an inch from the edge of the tibia and is readily uncovered by incising the fascia, which may be thick, with the knife.

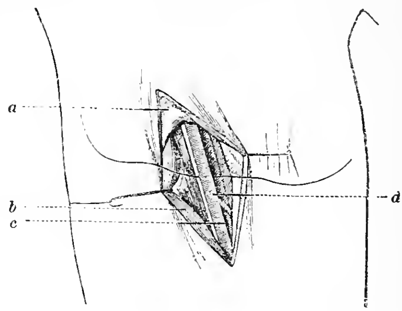
The operator may mistake the gastrocnemius for the soleus because the incision was made too far from the tibia, or he may cut too close to the tibia and, therefore, fail to recognize the soleus and, as a result separate not only it but the deeper muscles from the tibia and get down to the interosseous membrane.

The knife should be held with its edge toward the bone in order not to make an oblique section of the soleus. There is an intramuscular septum in the middle of the soleus which is parallel to the septum of deep fascia under which the artery lies. This may mislead the surgeon, who will

think he has cut entirely through the muscle when he has only gone half-way.

Femoral Artery.—The common femoral artery and the upper part of its continuation, the superficial femoral, have their course indicated by a line drawn from a point midway between the anterior superior spine of the ilium and the symphysis of the pubes, where the pulsation can always be felt, to the prominence of the internal condyle of the femur. This line bisects Scarpa's triangle, running from the centre of the base through its apex. Scarpa's triangle is bounded by Poupart's ligament above, the sartorius muscle externally, and the long adductor muscle internally. The apex of the triangle at the point of junction of these muscles is on the inner side of the thigh. The vein corresponding with the arteries lies upon their inner side except near the apex of Scarpa's triangle, where it passes behind the artery, and finally gets to the outer side. The anterior crural nerve is on the outside of the arteries, and at a distance, except near the apex of the triangle, where one of its branches lies close to the vessel. It is well to remember that in fat persons the fold of the groin is a little below Poupart's ligament, and does not, as in lean patients, correspond with the ligaments.

Fig. 123.



Ligation of femoral artery. (Smith).

The superficial femoral artery is to be ligated where it is crossed by the sartorius muscle at the apex of Scarpa's triangle, which is about four inches below Poupart's ligament. The thigh should be everted and an incision three or four inches long made at this point, a little oblique to the line of the artery, avoiding the internal saphenous vein. When the inner border of the sartorius is recognized by its fibres passing obliquely downward and inward, the proper landmark or guide has been found. The edge of this muscle should be turned up and under it will be discovered the sheath of the artery, running in the direction indicated by the line already mentioned. The vein will probably be a little behind the artery, though on its inner side. The ligature should be passed from within outward. The artery is so superficial that its pulsation can usually be felt through the tissues before the first incision is made.

The common femoral artery is readily secured by making an incision two inches long parallel to Poupart's ligament, and a half inch below its centre. Some lymphatic glands may require pushing aside when the superficial fascia is being divided; after which incision of the deep fascia will disclose the sheath of the artery. The vein is on the inner side of the artery, hence the ligature should be carried around from the inner side.

External and Common Iliac Arteries.—The course of the common iliac artery and its direct continuation, the external iliac, is indicated by a line drawn from the left side of the umbilicus, on a level with the top of the iliac crest, to a point midway between the anterior superior spine of the ilium and the symphysis of the pubes. The upper third of this line corresponds with the common, the lower two-thirds with the external iliac; though this proportion often varies, because the bifurca-

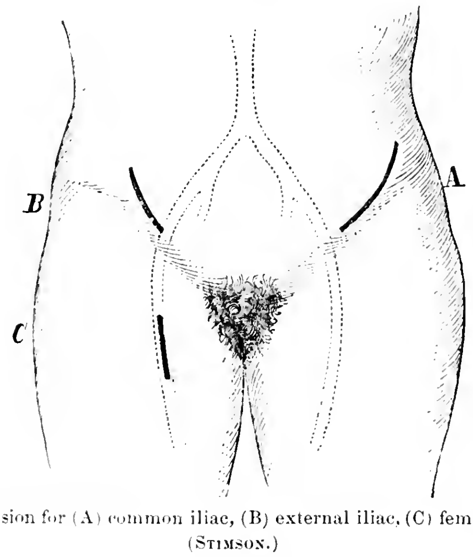
tion of the common trunk into external and internal iliac varies in location.

The common iliac has the peritoneum just in front of it and is crossed at its lower end, near the point of bifurcation, by the ureter. The rectum as it descends into the pelvis also crosses the left artery. The lower part of the common and the entire length of the external iliac lie along the inner border of the great psoas muscle. The common iliac vein on the left side of the body lies at the inner side of the artery; on the right side it is behind the artery at its lower part, and on the other side above. This may be memorized by the fact that each common iliac vein lies on the right side of the corresponding artery.

The external iliac arteries are covered by the peritoneum, and have the veins lying internally and the genital branch of the genito-crural nerve lying externally. Near Poupart's ligament the external iliac is crossed by the vas deferens and the spermatic vessels, and gives off two branches. It must not be tied here.

The external iliac artery is reached for ligation by a crescentic incision of four or five inches in length, with its convexity downward, beginning an inch above and an inch outside of the middle of Poupart's ligament, and ending at a point an inch above the anterior superior iliac spine. This will probably cut the superficial epigastric artery, which will require tying. The tendon of the external oblique muscle, which is exposed, must be divided to the same extent as the skin, either with the knife's edge held perpendicular to its surface, or upon a director.

FIG. 124.



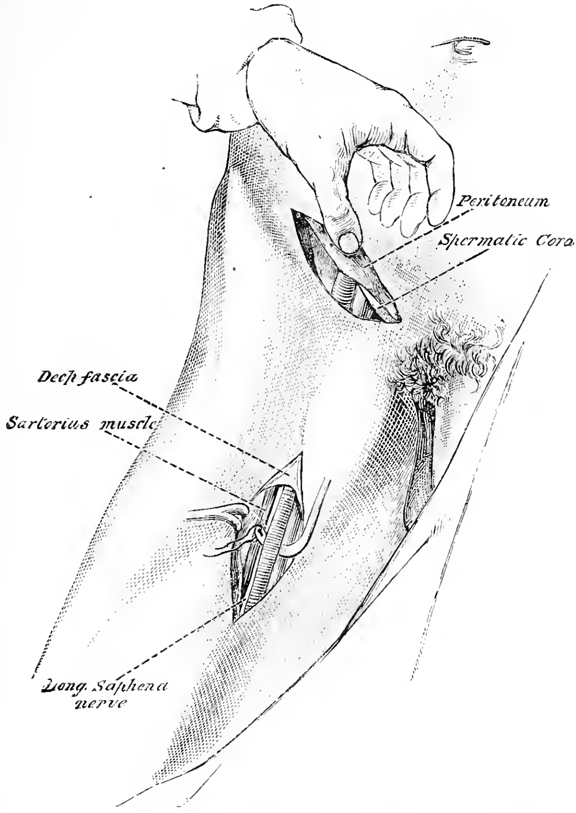
Lines of incision for (A) common iliac, (B) external iliac, (C) femoral arteries. (STIMSON.)

The fibres of the internal oblique and transversalis muscles must be divided in the same way. If it is preferred, the last may be divided on a grooved director. The transverse fascia is now exposed. It may be thick and white or thin and transparent. It should be carefully torn

through with the forceps and fingers, when the bluish, though rough looking, outer surface of the peritoneum will be seen crossing the bowels.

The operator with his finger loosens this serous membrane from the front of the iliac fossa and vessels; beginning at the external end of the wound, where the attachment is least strong.

FIG. 125.



Ligation of external iliac and femoral arteries. (BRYANT.)

The assistant, who, during the incision was pressing on the belly wall to make the muscles tense, now puts a broad spatula into the wound and draws the peritoneum inward.

The artery and vein in a sheath of fascia will now be felt along the inner border of the belly of the psoas. After the sheath has been opened, the aneurism needle is carried around from within outward.

The incision given should be carefully followed as to length and curve through its entire depth. It should not go nearer the middle line lest it cut into the external abdominal ring, nor lower, lest it open the inguinal canal or cut the deep circumflex iliac artery. When the director is pushed under the tissues it should be kept longitudinal, so as not to puncture deeper layers unawares. It is wise not to incise all the way to its end, lest the peritoneum be folded over the extremity and thereby be wounded.

The common iliac artery can be reached by an incision similar to that used for the external iliac, but beginning an inch higher and extending about two inches further upward toward the last rib. The muscles and transversalis fascia are divided in the same manner as just described. When the peritoneum is pushed inward the ureter and spermatic vessels are carried with it, as they adhere to its outer surface. The artery can then be felt near the promontory of the sacrum. The needle should be carried from right to left on each side of the body, as the vein lies to the right of the artery in each instance.

The ureter might be tied instead of the artery if the operator is not careful, and in case of high bifurcation of the common iliac the ligature might in error be applied to the external iliac artery.

Internal Iliac Artery.—This vessel extends from the bifurcation of the common iliac at the sacro-iliac junction to the top of the great sacro-sciatic foramen with the ureter and peritoneum in front, its vein and the sacral plexus of nerves behind. It is ligated by an incision similar to that for tying the common iliac.

These methods of reaching the common and internal iliac arteries are somewhat complicated and difficult because of the great depth of the wound. It is a question whether a laparotomy in one of the semilunar lines with ligation of the vessel through the peritoneum is not simpler, and therefore easier and safer.

Arterial Varix or Varicose Arteries.

Arteries may become dilated and elongated, presenting a condition similar to varicose veins. The term arterial varix is generally applied to such a pathological change if the artery affected be a large vessel, such as the temporal, facial, or iliac, while to similar dilatation of the terminal subcutaneous arterioles of a normal diameter of about one-fiftieth of an inch the term cirsoid aneurism has been applied. I shall discard the latter name, since the condition has no pathological resemblance to aneurism, and use the term arterial varix, or varicose artery, for dilatation and elongation of *preëxisting* arteries of any size, provided their preexistence can be demonstrated clinically or microscopically. When there is a development of new vessels with arterial characteristics, it is proper to call the mass or tumor an arterial angeioma. It may at times be difficult to determine clinically whether the pulsating growth is composed principally of new vessels or preëxisting ones.

Fig. 126.

Arterial varix of the palm and fingers. (Agnew.)

A varicose artery in addition to being generally dilated, may show irregular pouches or sacculations. The middle tunic especially is thinned

until the artery looks like a vein; hence the blood current may become very sluggish. The cause of the change is probably some obscure vaso-motor disturbance leading to loss of muscular tone in the middle coat. Atheroma seems not to be a factor in the causation.

Arterial varix is exhibited as a pulsating tumor with an irregular, nodulated surface, which usually shows the position beneath the skin of the dilated arteries. When the hand is applied to the tumor a vibratory thrill is felt that in some cases resembles the wriggling of a mass of worms. Pulsation may be distinct and is more general than the limited pulsation felt in aneurismal varix or arterio-venous fistula between vein and artery. Auscultation reveals a blowing or cooing murmur. Pressure upon the afferent artery stops all movement and murmur. If there are several arteries, pressure on one merely diminishes these signs. When the disease affects a number of small arterioles the tumor has a spongy feel, and the outline of the vessels is not traceable through the skin. If an arterial varix shows no tendency to increase in bulk, and is not threatening hemorrhage from inflammatory and ulcerative processes, it should be let alone. If treatment is demanded, excision or ligation should be done in the manner described in the section which discusses angeiomas. This is better, and probably safer, than injection with coagulating fluids.

CHAPTER XVII.

DISEASES AND INJURIES OF BONES.

PERIOSTITIS.

Causes.—Periostitis, or inflammation of the fibrous membrane covering the exterior of bones, is caused by injuries, such as contusions, and by certain constitutional conditions, such as rheumatism, gout, and especially syphilis. Agnew believes that it may be due to violent traction of muscles inserted into the periosteum. The vessels of the periosteum, of the bone, and of the medulla are continuous through the ramifications of Haversian canals and spaces. Hence, inflammation of one of these structures is usually associated with inflammation of the other in the same locality. As ostitis is really an inflammation of the medulla within the bone spaces, it may be the cause of periostitis, and periostitis may similarly be the cause of ostitis or of myelitis.

Pathology.—The pathological changes seen in periostitis are congestion, thickening, and softening of the membrane due to rapid cell-proliferation and accumulation of the wandering blood cells. The deepest layer of the membrane, which is that which causes bone growth, is especially active in cell formation; hence, the membrane is raised from the bone by a subjacent exudate and becomes easily detachable. The bone immediately beneath the inflamed area also becomes inflamed and softened to a limited extent. If resolution occurs, this exudate is absorbed, and the elevation, or node, caused by the cells and fluid beneath the periosteum disappears. At other times, the inflammation does not subside so easily; this new material becomes organized into bone, and there is left a permanent change in the contour of the skeleton. The entire bone may be enlarged if the periostitis is wide-spread. Flattened bony elevations or nodes are of frequent occurrence after syphilitic periostitis, and often aid in establishing the constitutional causation of later obscure lesions in other parts and tissues. In periostitis, if pyogenic bacteria be present, suppuration may take place between the membrane and bone, giving rise to subperiosteal abscess, also called cortical osteomyelitis, and secondarily causing superficial necrosis of the bone in the vicinity. Periostitis of syphilitic origin occurring in the later stages of this constitutional disease is more prone to suppuration than when it occurs earlier. In diffuse suppurative periostitis the membrane is separated from a large surface of bone, and the vessels going to the bone are injured and stretched and become the seat of thrombosis. The surface of the bone, therefore, becomes necrotic. If there is concurrent suppurative inflammation of the marrow in the medullary canal, which is not infrequently the case, the necrosis will involve the entire thickness of the bone and not merely the outer surface. Death from pyæmia may occur in such conditions. Subperiosteal hemorrhages are sometimes found. This bleeding may be mechanical and due to forcible and rapid dissection of the membrane from the bone by the sudden inflammatory exudation. Acute infective periostitis is a

variety of suppurative periostitis and is liable to be followed by septicæmia or pyæmia. It is usually associated with acute infective osteomyelitis, and is, of course, due to bacteria, probably the bacteria of ordinary suppuration.

SYMPTOMS.—The symptoms of circumscribed periostitis, which is by far the most common form, are pain, often worse at night, tenderness on pressure, heat of the surface, circumscribed swelling and, perhaps, local œdema. Persons whose occupations require them to work at night and sleep in daytime may have more pain during the day than at night. The deposition beneath the membrane may cause the parts to feel baggy or puffy on strong pressure with the fingers. The swelling has not abrupt edges, but gradually reaches the level of the surrounding surface. The pain is often excruciatingly severe and of a throbbing character. Redness of the surface occurs late and sometimes at no time during the progress of the inflammation. The tibia, clavicle, ulna, and cranial bones are very frequently the subjects of syphilitic periostitis. Diffuse periostitis, which is probably usually infective, is very rapid in its course, while the circumscribed variety is often a disease of slow development and progress. The former attacks particularly the long bones of tuberculous persons in early life, and is accompanied by violent constitutional disturbance. In this violent periosteal lesion chills, high fever, and delirium occur, and are accompanied by rapidly-spreading inflammation of the limb, which is shown by great pain, swelling, œdema, and enlarged veins from obstruction to deep circulation. Ostitis, endositis, epiphysitis, and even arthritis often follow in its train. Death from septicæmia or pyæmia is not uncommon. Diffuse suppurative periostitis of the digital phalanges is often called whitlow or felon.

The diagnosis of circumscribed periostitis is easy. It is usually syphilitic when not traumatic. The diffuse or suppurative form may be mistaken for diffuse cellulitis, but, as a rule, it does not extend beyond the joints at the extremities of the bone affected. Suppurative cellulitis frequently passes beyond joints. From rheumatism, periostitis is discriminated by the swelling, which is not apt to be situated at the joints, and by the evidences of suppuration in the purulent form of periostitis. Acute infective periostitis is often mistaken for rheumatism, and must be remembered as a possibility when such violent general symptoms, in young persons, are associated with pain about the tibia and femur.

TREATMENT.—The treatment of acute periostitis of a sthenic type should consist of cathartics and diaphoretics combined with anodynes. The asthenic cases demand iron, quinine, and stimulants with concentrated food and anodynes. Locally, leeches, lead water and laudanum, and moist antiseptic dressings should be employed in the acute form; tincture of iodine and blisters in the more chronic cases.

As syphilis is probably the commonest cause of non-traumatic periostitis full doses of iodide of potassium should be administered. The dose should not be less than 10 grains three times a day after meals, and may be increased to 30 or 40 grains in a rebellious case. As this lesion is a manifestation of the later stages of syphilis, the iodides are possibly more efficacious than mercury. The two remedies may be combined. The pain of syphilitic periostitis, often called syphilitic neuralgia, can frequently be promptly cured by these large doses of potassium iodide. When the pain of periostitis of any origin does not promptly subside, free incision of the tense fibrous periosteum is the proper surgical remedy. The tension due to the subperiosteal exudation is thus removed, and as a

consequence pain is relieved, resolution favored, and the danger of secondary necrosis lessened. In non-suppurative cases the incision is to be done subcutaneously by passing a tenotome through the skin in one or more places and incising the periosteum freely and deeply in every direction by pushing the knife as far under the tissues as the handle will allow. In suppurative periostitis free incision must at once be made through the skin and other tissues directly down to the bone. If the bone becomes necrotic notwithstanding this line of treatment, it should be removed as soon as the patient can bear the shock. Some reproduction of bone may subsequently take place from the shreds of the periosteum not destroyed by the violent inflammation and from the medullary tissue in the interstices of the living bone. If great destruction occurs from involvement of the medullary membrane and the joints amputation may be demanded.

Ostitis or Osteomyelitis.

Causes.—Ostitis or osteomyelitis may arise from contusions of bone, fractures, amputations, and other injuries, and from various constitutional deteriorations and mycotic affections such as rheumatism, syphilis, tuberculosis, and low fevers.

Pathology.—Inflammation of bone is pathologically identical with inflammation of the soft tissues, for it is the soft or animal tissue in the Haversian spaces, canaliculi, and lacunæ of the bone that undergoes the morbid process. The earthy constituents cannot inflame; they only show the impress of the alterations induced in the vascular and other living tissues. When the inflammation affects the soft structures within the spaces mentioned the term ostitis is used; when the marrow in the medullary canal is the seat of these changes the term myelitis or endostitis is used. As ostitis is usually, if not always, associated with myelitis, surgeons now use the word osteomyelitis almost exclusively, having dropped to a great extent the word ostitis, except when speaking of chronic inflammations, when ostitis is still used to some extent.

The increased vascularity of inflammation is followed by softening of the bone, due to absorption of the earthy structures and the filling of the vascular canals and spaces with embryonic cells and migrating blood corpuscles. The coalescence of numerous canals and spaces by the absorptive process exerted on their walls, makes the bone much more porous, while the increase in cellular elements gives it a soft and spongy character. This process has been called "rarefying ostitis," or "dry caries," because the bone is eaten away as if ulcerated, but without any pus formation. Changes in shape of long bones or vertebræ, due to this process, occur, hence the name "deforming ostitis." This is the change that occurs when aneurisms cause absorption of the bone, when sequestræ are loosened, and when the ends of broken bones are rounded off. The inflammatory cellular infiltration or exudate may be absorbed and the ostitis may thus be terminated by resolution without leaving permanent change. This is possible only in the early stages, or in a very mild degree of inflammation.

More frequently the cells become converted into osseous tissue, which, though formed in the widened Haversian canals and medullary spaces, encroaches upon the calibre of these channels so much that they become smaller than they were originally. Thus the bone becomes harder, more compact or ivory-like, and, as a consequence, heavier than it was previous

to the occurrence of ostitis. This is the pathological nature of most cases of chronic ostitis. As enlargement takes place both in diameter and length during the stage of softening and swelling because of the coincident periostitis and epiphysitis, an inflamed bone which is thus sclerosed becomes of greater bulk as well as harder than it was previously. This sclerosis or "condensing ostitis" may be found accompanying "rarefying ostitis" in the same specimen.

The osteomyelitic inflammation may terminate in softening and degeneration which will cause the so-called "cold" or "chronic abscess" of bone. The puriform fluid contained in such cavities is not true pus. It is well to remember that such abscesses are probably always due to the tubercle bacillus. When they occur in syphilitic persons it is possible that the syphilitic taint favors infection with the tubercle bacillus. Pus from inflamed bone contains oil globules in considerable numbers and is due to infection from pus bacteria. Septic osteomyelitis is then the condition. This last process is acute. Ulceration of bone, termed caries, and mortification of bone, called necrosis, may follow ostitis. The various stages and results of ostitis may often be found in different parts of the same bone. When repair takes place after deforming ostitis, tubercular ostitis or traumatic ostitis after fractures, the process is one of ossification of granulation tissue which fills in the gap. It is simply a bony transformation of scar tissue. This process is well shown in some cases of curvature of the spine cured without the formation of puriform discharge.

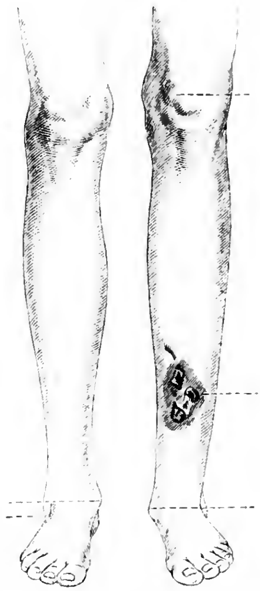
Acute inflammation of the bone and marrow may be traumatic; or it may occur without visible injury, and is then called spontaneous osteomyelitis. In the latter case it is usually diffuse; in the former case it may be diffuse, but frequently is not so. In acute diffuse osteo-myelitis the marrow is injected and swollen, purple or marked with red, yellow, and purplish streaks, and protrudes in a fungous mass from the medullary canal when the bone is sawed. Oil and pus escape from the canal when it is opened. Abscesses and thrombosis of veins are found in the tissues surrounding the diseased bone; bacteria are found in the marrow and other structures, and pyæmic abscesses frequently arise secondarily. It may occur in short or flat bones as well as in long bones, and is due to mycotic infection. The microörganism or microörganisms are probably those known as pyogenic. The periosteum is often involved in a similar inflammation, but not necessarily so. The bones are in severe cases stripped of periosteum and become necrotic from one epiphysis to the other. Separation of the epiphysis from the shaft is common, and is due to destruction of the intervening cartilage.

Symptoms.—The symptoms of ostitis are with difficulty differentiated from those of periostitis and myelitis, with which the former affection is so frequently accompanied. In the early stages the symptoms are often very indefinite. Dull aching or gnawing pain, especially severe at night and varying with the conditions of the weather, is a common symptom in chronic ostitis, and the inflammatory signs spoken of in the discussion of periostitis will probably be observable in the later stages.

Enlargement of the bone without much change in its outline was formerly thought to be characteristic of ostitis, but it is due largely to the concurrent periostitis. In ostitis, unaccompanied by much periostitis, irregular flattened swellings on the surface of the skeleton change the contour greatly. Some of the increase in size in these inflammations is apparent, being due to the overlying soft tissues. A feeling of weakness and heaviness in the limb is frequently described by the patient.

Lücke has employed percussion with a small rubber-tipped hammer to determine the existence and exact seat of osseous inflammations. Corresponding parts are struck and the existence of increased sensibility determined; and then its superficial or deep location estimated by the force required to develop tenderness. There is greater dulness on percussion when the bone is compact, or infiltrated with inflammatory exudations, than elsewhere.

Fig. 127.



Hypertrophy of tibia from syphilitic ostitis (inherited).

Acute inflammation of the bone and marrow, called acute osteomyelitis, or acute infective osteomyelitis, may be associated with a similar periostitis, and when it occurs without a recognized injury is often mistaken for rheumatism. The sudden development of fever with chills and delirium, accompanied by severe pain in the limb of a person so young that the epiphyses have not yet become united to the shafts, should be carefully examined and watched. If redness and œdema occur, and especially if crepitation from inflammatory destruction of the epiphyseal cartilage is developed, or if the joint is involved, the diagnosis of infective osteomyelitis is confirmed. Abscess under the periosteum and muscles, necrosis, septicæmia, and pyæmia are later symptoms. Thickening of the bone and early ossification of the epiphyseal cartilage will probably occur in cases of only moderate severity. This disease is most frequently found in the long bones of the lower limb; and occurs before ossification of the epiphyseal cartilages, which is not completed in the tibia and femur until about the twentieth year.

Treatment.—The treatment of ostitis is almost identical with that of periostitis. If medical remedies fail a deep periosteal incision should be made, which may be at once, or subsequently, followed by longitudinal section of the bone with a Hey's saw or the circular saw of the surgical

engine. This incision should be deep enough to go into the cancellated structure or medullary canal of the bone. Cutting out one or more disks with the trephine answers a similar purpose in relieving tension and pain, and is often better, even if there is no abscess cavity in the bone to be curetted.

Acute infective periostitis and osteomyelitis must be met by early and free incision of soft parts and periosteum, down to the bone, and thorough disinfection of the diseased tissue with antiseptic solutions. Corrosive sublimate solution (1 : 1000 or 1 : 2000) is probably the best; but it must be watched if repeated daily, so that it may not produce toxic effects. Beta-naphthol solution may be used in its stead. Free drainage and antiseptic washing of the cavity daily are essential. Separated epiphyses should be kept in position by splints; dead portions of bone removed and the patient kept alive by tonics, good food, and stimulants until the force of the mycotic poison has been exhausted. When the infective inflammation does not involve the periosteum to any extent, but is limited to the bone and marrow, the general treatment is the same as in associated periostitis and osteomyelitis.

The local treatment consists in boring into the bone with a trephine and scraping out with a curette the inflamed suppurating marrow. If necessary, more than one trephine opening may be made, or two or more such holes may be connected by cutting away the intervening bone with a chisel. Complete removal of the diseased tissue and disinfection of the cavity are the indications.

Necrotic bone should be removed when it becomes loosened from the living osseous tissue. This is usually a secondary operation, unless trephining and curetting have been done in the early stages. The latter operations are indicated as soon as a probable diagnosis is made. It is better to operate too early than too late. Amputation may be required to save life in infective osteomyelitis and periostitis.

Necrosis or Mortification of Bone.

Definition.—Necrosis is death of bone in masses or in bulk, in contradistinction to caries, which is death in minute particles. It is pathologically identical with mortification or gangrene of soft tissue.

Causes.—Necrosis is caused by anything that at once destroys vitality of bone, such as intense heat or cold, crushing pulpefying injuries; and by whatever prevents the continuance of the blood circulation through the Haversian canals and their ramifications, thereby interfering with the bone's nutrition. Obstruction of these blood spaces by the exudate of ostitis, and detachment of the periosteum or inflammation of the marrow by reason of suppurative inflammation of these structures, are the most common direct causes of necrosis. Osteo-myelitis, whether central (endostitis) or cortical (periostitis) is probably the most frequent cause. They act by interfering with proper blood supply, which is arrested by stretching, compression and thrombosis of the vessels. Syphilis and tuberculosis may, by inducing ostitis, act as remote causes. The depressed vitality of old age and of eruptive fevers, division or embolism of the nutrient artery of a long bone, and exposure to the fumes of phosphorus are occasionally causes of mortification of bone. If a piece of bone is torn loose from its periosteal attachments, as happens in compound fractures, necrosis is not apt to occur, unless the wound is infected with putrefactive or pyogenic

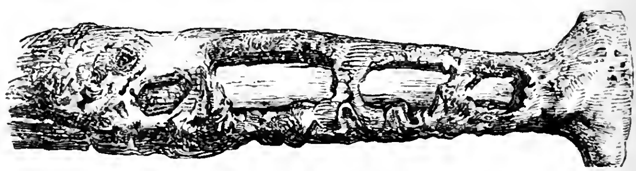
germs. This proves that it is the septic character of a given periostitis that inclines it to cause necrosis.

Pathology.—The occurrence of necrosis more frequently in compact than in cancellated osseous structure is due to the greater ease with which the circulation is obstructed in the former unyielding structure. The usually dry condition of the dead bone shows the dependence of this necrosis on deprivation of blood supply. If death occurs in cancellated tissue, which is normally more vascular than the compact, the necrotic tissue, especially when the destruction is sudden, is moist instead of dry.

The moist form of necrosis is seldom seen except in military practice, and then usually in the cancellated portions of bones. It is liable to occur as a sequence of severe gunshot contusion of bone or compound fractures, and is evidently the result of septic infection of some sort. The dead bone has a dirty-gray or greenish-brown color, is moist and soft and emits a very offensive odor. The periosteum is usually found in a sloughing condition, and shows little tendency to form new bone. Death from pyæmia is a common result of moist necrosis.

In the ordinary variety of necrosis the devitalized bone is dry and hard, and has a relatively large proportion of mineral constituents. When struck with a probe it often gives a sonorous note, but is not sensitive to touch, nor does it bleed. Its color is yellowish-white, unless it has become blackened by contact with putrid pus or other agents. The necrotic action may pertain to the surface of a bone (superficial necrosis) to a portion some distance below the, perhaps healthy, bone surface (central necrosis), or to the entire thickness of the bone (total necrosis).

Fig. 128.



Central necrosis, showing new bone and cloacæ.

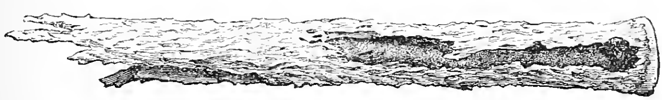
After osseous tissue has died, it is separated from the living bone by the process of rarefying ostitis or ulceration, exactly as gangrenous parts are separated from soft tissues. The adjacent bone becomes inflamed, softened, and ulcerated, and soon a line of demarcation appears. It requires a long time, varying from weeks to months, according to the extent and situation of the necrosis, to effect complete detachment. Very often pus infection occurs and suppuration takes place between the dead and living bone. During the accomplishment of this process the overlying periosteum becomes abnormally active in producing bony tissue, probably because of the induction of a chronic periostitis, and deposits a layer of new bone. This new bone may form a covering over the necrosed part, or, if the latter is central, increase the thickness of the surrounding living bone. In this manner the devitalized bone is usually, by a process of invagination, enclosed in a bony sheath or involucrum of irregular shape, which, however, conforms somewhat to the outline of the original bone. If the periosteum has previously been entirely destroyed, no invagination occurs. The dead portion of bone enclosed in the sheath is called the sequestrum, while the leaf-like portions detached in cases of superficial

necrosis are termed exfoliations. In cases of total necrosis the endosteum may also furnish new bone, so that the dead structure lies between two layers of newly-formed osseous tissue. There is usually no invagination in necrosis of the skull or of the cancellated bones.

Through the living bone, whether original or newly formed, which covers the sequestrum, narrow channels or fistules, called cloacæ, are established by the discharge, formed at the line of demarcation, making its way to the surface. These cloacæ communicate with sinuses extending through the overlying soft parts of the cutaneous surface, which sinuses are the remains of collapsed abscesses that were developed soon after pus formed in the bony structures.

The surfaces of a sequestrum or exfoliation are usually rough and jagged, because the living bone has been eaten away from it by rarefying or suppurative ostitis. The external surface of an exfoliation is sometimes quite smooth, since it may have been originally the normal surface of the bone. The sequestrum may be dense or spongy, according as it has been sclerosed or rarefied before death. After some amputations of the thigh in which the nutrient artery has been divided, necrosis of the area of bone nourished by this artery occurs, while the regions nourished by other vessels coming from the periosteum and endosteum remain healthy. As a result, a tubular or cylindrical sequestrum is formed and may, when finally detached, be pulled out from the sawn end of the bone.

FIG. 129.



9⅞ inches

Cylindrical sequestrum from femur.

SYMPTOMS.—The early symptoms of necrosis are those of ostitis followed by inflammation, and often of suppuration of the overlying soft parts. Through the openings or sinuses left after the evacuation of the pus, a hard and more or less rough surface can usually be felt with the probe if the necrosis is superficial. This is the dying or dead bone uncovered by periosteum. Bare bone, however, is not necessarily dead bone, for after periostitis and ostitis of a simple kind we may have an ulcerated surface of bone that is slow in healing. In cases of central necrosis the probe must be passed through the sinuses in the soft parts and the cloacæ in the involucrum or sheath before the rough sequestrum can be felt. Until sinuses and cloacæ have been formed it is practically impossible to diagnosticate necrosis from ostitis or tubercular caries and abscess. The fever and other constitutional symptoms may be marked during this early stage, but are apt to decrease in severity with the evacuation of any purulent accumulation which may become thereafter the seat of putrefaction from germ infection. From time to time, however, exacerbations of the symptoms may occur, and new abscesses may form. The symptoms during this, the dying stage, are more chronic in progress when necrosis happens in spongy bone. When the osseus tissue is killed at once the symptoms of this stage are absent.

The stage of separation, as the period occupied in detaching the dead structure may be termed, has characteristic features.

Chronic discharge from the cloacæ and overlying sinuses, increased

thickness of the bone and gradual impairment of health, if the disease is extensive, are the most prominent. Symptoms of waxy degeneration of the liver or kidneys may arise. The time occupied in separation varies from a few weeks to many months; being shorter in the upper limb than in the lower and when the necrosis is superficial or circumscribed than under opposite conditions. That separation has been accomplished is known by the motion that can be communicated to the sequestrum by a probe passed into the openings. This is sometimes better determined by introducing two probes, one near each end of the sequestrum. Sometimes the sequestrum is not movable, even when completely detached, because it is imbedded in the granulations on the inner surface of the sheath. If this condition is suspected a strong probe should be used to force the sequestrum down upon the granulations until they are flattened and the cavity enlarged. Motion can probably then be detected.

Prognosis.—The prognosis in necrosis as to final restoration of the usefulness of the part is generally good, except in acute septic cases. The disease seldom extends beyond the epiphyseal cartilages, and, after removal of the dead bone, the sinuses heal, leaving, however, some deformity in contour. Death at times does occur in the early stages, as, for example, in cases following acute septic osteomyelitis or periostitis; so also exhaustion from prolonged suppuration or pyæmia may lead to a fatal issue. Again, death may result from secondary implication of other structures. This is illustrated by brain disease following necrosis of the skull, arthritis subsequent to disease of the patella and laceration of the femoral artery by necrotic spicules from the femur. Pyæmia from moist necrosis is not uncommon; but fortunately this form of bone disease is quite rare.

Treatment.—The indications in the first stage are to moderate accompanying inflammation by treating thoroughly the causative osteomyelitis or periostitis, to open abscesses early, and to keep up the general health. A blister will sometimes hasten suppuration and thus be beneficial. Early incision of the periosteum is often valuable, since it relieves pain and tends to prevent extensive destruction of this membrane and the bone by suppuration. So trephining the inflamed bone and scraping away the diseased medullary tissue are valuable operative procedures. Disinfectant solutions should be freely employed to allay fetor; and all cases should be treated with rigid antiseptic measures. As soon as the dead bone is loose, it should be removed by operation. An exfoliation can be lifted away with a chisel after simple incision of the musculo-cutaneous coverings. When the bone has been devitalized by caustics or burning, and the dead area is easily determined, there is no objection to cutting it away with the chisel even before detachment has taken place, for it hastens the cure. A sequestrum should seldom be removed until it is entirely loose. To effect its removal an opening should be cut in the encasement by means of small sharp chisels and a hammer, or with a saw or trephine, until the sequestrum can be seized with strong forceps and pulled out. Sometimes the cloacæ simply need enlargement; at other times the bridge of new bone between two of them must be cut away. The surgical engine, by which circular saws and burrs can be rotated with great rapidity, may be very useful in these procedures.

After application of the Esmarch apparatus an incision should be made in the line of the principal sinuses and cloacæ, and the exposure of the bone will then enable the surgeon to determine upon the proper method of reaching the necrotic piece. The encasement should be freely cut, but in such a manner as not to weaken the bone more than necessary,

nor to fracture it transversely. Occasionally it will be found easier to get the sequestrum out after it has been divided into portions by the bone-cutting forceps. The cavity left is generally lined with granulation tissue, but in tubercular subjects its walls may be carious. Such carious bone should be scraped away with a gouge. In getting access to the sequestrum, the surgeon should not feel compelled to follow the sinuses or cloacæ; any safe path of attack which gives best opportunity for thorough removal is justifiable.

After the operation is completed the wound should be stuffed with dry antiseptic gauze, the limb enveloped in a similar dressing, and a roller bandage firmly applied to the parts before the elastic band of the Esmarch apparatus is removed.

Subsequently to this operation, called sequestrotomy, the encasement contracts, new bone is formed in the cavity of the sheath, as well as under the preserved periosteum, and the sinuses and cloacæ become closed. The medullary cavity, if destroyed, is, as a rule, not reëstablished.

There are some circumstances in which it is probably better to operate before detachment of the sequestrum is complete, notwithstanding the possibility of thus tearing away portions of the living bone. This is the case in acute necrosis from subperiosteal abscess and septic osteomyelitis and in moist necrosis; for more extensive destruction of the periosteum and septicæmic complications may perhaps be obviated by early excision of the dead structures by means of saws. The periosteum should be peeled off and preserved in these operations so that the flail-like limb, often left, may have an opportunity of becoming solidified and useful. An objection of some force against waiting too long for separation in ordinary chronic dry gangrene is the very great thickness of the encasement that occurs. Three to six months is probably long enough to wait in the majority of such cases.

Fig. 130.

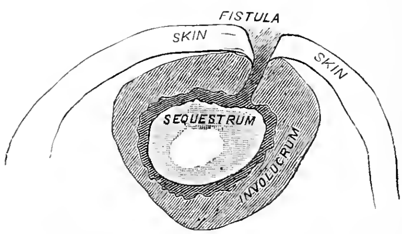


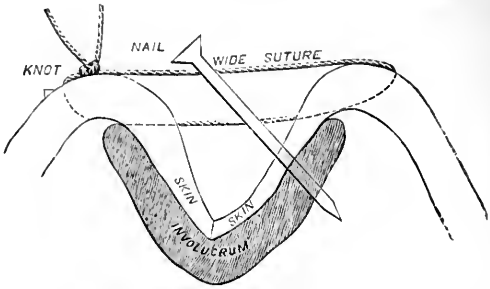
Diagram of a transverse section, showing relations of sequestrum, involucrum, fistula and skin. (Gerster.)

Small pieces of healthy periosteum or of bone, taken from man or the lower animals and kept aseptic, have been inserted in the gaps left by extensive operations of this kind. Such bone chips act as centres of bone formation, thus hastening and perfecting the regeneration of the removed shaft. It is absolutely essential that the cavity from which the sequestrum has been taken be made perfectly aseptic by the removal of every particle of diseased bone, diseased granulations, and discharge. Herein lie the difficulty and frequent failure of the method. These osteo-plastic operations deserve further trial in cases in which the bone has been extensively destroyed.

The methods of performing sequestrotomy, adopted before the advent of modern antiseptic surgery, gave good results; though the healing of the remaining wound was very prolonged. It was always the seat of protracted suppuration. Septic complications were, however, uncommon; because the dense inflammatory infiltration of the surrounding osseous and other tissues rendered septic absorption difficult, and the open wound with rigid bony walls made drainage thorough and perfect.

Antiseptic surgery has much shortened the process of healing by making possible the implantation of cellulo-cutaneous flaps and the organization and ossification of aseptic blood-clots.

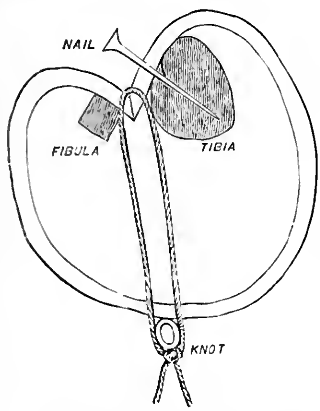
Fig. 131.



Neuber's method. Top of involucrum removed, skin flaps turned into the bottom of the bone cavity. (Gerster.)

Implantation of cellulo-cutaneous flaps may be done in order to cover the fresh surface of living bone, left after cutting away all diseased bony structure, and thereby obtain primary union between the bone and the turned-in cutaneous flaps. This leaves little or no bony surface to heal by granulation and hastens cicatrization; though, of course, a defect is left in the contour of the part. This defect would also occur, even if the process of implantation was not adopted. The turned-in flaps are held in position by sterilized nails driven through the flap and into the bone, and by sutures passed through the skin at the edges of the cavity and carried across the gap; or by sutures carried through the edges of the flaps and then brought out and tied upon the opposite side of the limb. These different methods are shown in the cuts from Gerster. The nail and sutures are removed at the end of three or four weeks; which, if the wound has been made and kept aseptic, will probably be the date of first change of dressing.

Fig. 132.

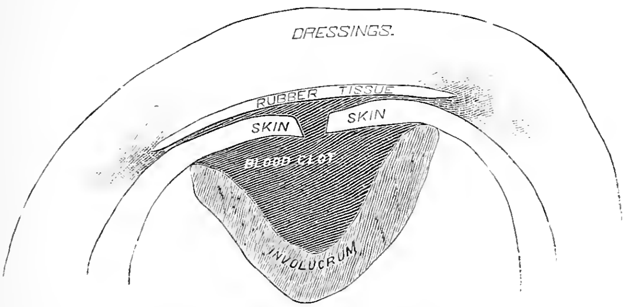


Implantation of cutaneous edges into the defect by transfixing catgut suture. (Gerster.)

The utilization of the blood-clot to aid in rapid cicatrization is accomplished by allowing the cavity to fill with blood, which clots and protects the wounded bone and other cut surfaces from septic irritation. The clot must, however, be kept aseptic and moist. This is done by covering the cavity with its contained clot with a piece of aseptic or antiseptic rubber-tissue, just large enough to overlap the borders of the wound. This is in turn covered with a voluminous dressing of dry sublimate gauze. The rubber tissue keeps the blood-clot moist, the dry antiseptic dressing absorbs all leakage of blood and serum.

This method of Schede is only possible when the entire mass or all the masses of necrotic bone are removed, when all the pus-infected membrane and granulation tissue lining the irregular tracks and cavities have been scraped away with absolute certainty, and when the cavities so made have been thoroughly sterilized by sublimate solutions and wiped clean with aseptic sponges. Gerster recommends sublimate lotion (1 : 500) to be first used, and to be subsequently washed away by a weaker sublimate solution, so that toxic effects may not follow the retention in the wound of small quantities of the strong lotion.

FIG. 133.



Schede's method. Diagram showing relations of organizing blood-clot. (GERSTER.)

If it is impossible to remove a sequestrum, excision of a portion of the bone or of the joint may be demanded. When the destruction of bone has been very great, or the patient is already sinking from exhaustion, due to long-continued bone-disease, amputation may be the most judicious treatment.

CARIES, OR TUBERCULAR ULCERATION OF BONE.

PATHOLOGY.—The inflammatory disintegration or erosion, called caries, is a process similar to ulceration in soft tissues, for the destroyed structure is removed in small particles, usually in a more or less liquefied form. In this circumstance caries differs from necrosis, in which the devitalized portion of bone is separated from the surrounding living osseous tissue in masses. Caries, therefore, corresponds with ulceration of soft tissues; necrosis with gangrene. As there is clinically a gangrenous ulceration of the soft parts, in which the two processes are combined, so there may be a necrotic caries of bone. Caries occurring without formation of pus is the so-called rarefying ostitis, or dry caries, which has been mentioned when ostitis was discussed. The form of caries most often seen is that in which the inflamed bone softens and disintegrates and causes the so-called "cold abscess" within or upon the surface of the bone. It is due to infection with the tubercle bacillus, and results from the breaking down of cheesy tubercles and inflamed bone.

Caries is the result of bone inflammation, and therefore depends upon the constitutional causes that induce ostitis. Ostitis is seldom, if ever, followed by liquefying caries unless the part is infected with the tubercle bacillus. Caries is often associated with inherited or acquired syphilis, but it is possible that syphilis may not be the actual cause of the caries, but simply a cause of lowered resistance which makes tubercular infection

easy. The cancellated tissue found in the extremities of the long bones and in the vertebræ, carpus, and tarsus is especially subject to the invasion of caries in those predisposed to this disease; but it may occur in any part of the skeleton. In tubercular persons it often follows injury. An ulcer of the soft parts may involve the periosteum and bone, and lead to caries.

Caries causes bone to become softened, porous and friable, and of a gray or brownish color before it breaks down into granular semi-liquid material. Sometimes the mineral constituents are dissolved out in the early stages of caries leaving the animal matter almost intact, so that the condition resembles that of a bone after maceration in hydrochloric acid. The organic constituents are destroyed subsequently. The removal of the disintegrated area by absorption and liquefaction leaves irregular hollows and cavities, called bone ulcers, which are occupied by the puriform products of the destructive process. The bone around the carious focus is apt to become indurated, because Nature endeavors to construct a barrier to the advance of the diseased action. If, however, the reparative power of the patient is poor, and he, from some inherent constitutional tendency is especially liable to bone disease, no such induration or sclerosis occurs, and the carious destruction spreads, involves the joints, and attacks adjacent bones.

Fig. 134.

Caries of bone.

The products of carious destruction consist of oil globules, degenerated cells, blood corpuscles, granular inorganic particles, and bone salts, with which are found the bacillus of tuberculosis. The products are the results of cheesy degeneration and emulsification of the osseous tissue. Small masses of necrosed bone will sometimes be found in the liquid, where the two processes, caries and necrosis, have coexisted. Caseous masses, or tubercles, will be found in the interior of the bone tissue, but the surface of the bone is usually involved, either primarily or secondarily, and localized periostitis and inflammation of the overlying soft parts arise. As a rule, a puriform collection, or "cold abscess," subsequently occurs in the tissues over the bone, which spontaneously opens and affords an avenue of escape for the liquefied bone material. So long as the carious disintegration continues to furnish a discharge, the sinus, left by the collapsed abscess, will not permanently close. Septic and pyogenic infection frequently occurs secondarily, and contributes to this condition. The sinus may cicatrize superficially, because but a small amount of fluid is formed in the depths of the track, but as soon as a few drops collect the tissues inflame and the orifice reopens. Very occasionally, as in some cases of caries of the vertebral bodies, so little discharge is furnished that it is entirely absorbed, leaving no caseous or puriform deposition. These may be called cases of dry caries.

Bone ulcers heal, as do ulcers in soft parts, by granulation and cicatrization. The loss of tissue is partially or entirely replaced by a granulation

tissue which undergoes ossification. The attempts of nature to fill up the cavities left after caries with scar tissue may be quite successful, so far as utility of the parts is concerned, if the destruction has not been very great; but depressions, though with rounded margins, are usually left. A great deal of bone is often formed in the endeavor to fill up deep cavities, which remains in the form of protuberances and bridge-like masses. The granulation tissue by which cicatrization is often effected may in turn become infected with the tubercle bacillus, and be, therefore, useless as a reparative agent, because of its continuing indefinitely to undergo cheesy degeneration.

Symptoms.—The early symptoms are necessarily those of ostitis and periostitis, or of both, and are followed by those of "cold abscess" of the soft parts. When this puriform collection has been evacuated, either spontaneously or by incision, the cavity does not promptly heal, but leaves a sinus which discharges thin puriform fluid continuously or intermittently. A probe passed down this sinus will come in contact with the bared and roughened bone, if the track is not too crooked to be followed to its bottom. The carious surface of bone is, as a rule, not tender when touched with the instrument, but it may bleed. If it is impossible to feel the diseased osseous tissue with the probe, the diagnosis may be made by persistent failure to effect permanent healing of the sinus, for which no other cause exists, and by chemical examination of the fluid showing a large amount of calcium phosphate. The discharge is often offensive in odor because of putrefactive infection, and contains gritty particles of bone. If there is much disease, several sinuous tracks with characteristic orifices surrounded by a little elevation of granulations will probably be found converging toward the same region of bone. When the overlying tissue has been ulcerated away, the diseased bone will be exposed to view, though covered in places more or less completely with fungous granulation tissue. Coxitis, angular curvature of the spine, called Pott's disease, and the various forms of joint disease, formerly called white swelling, are instances of caries or tuberculosis of bone.

When caries attacks bones near the joints, or involves the articular ends of the bone, as it often does, ankylosis is likely to occur, because of inflammatory involvement of the joint structures. On the other hand, the tubercular synovitis may occur first, and lead secondarily to caries of the bone by first involving the articular cartilages.

Treatment.—Iodide of iron, cod-liver oil, combinations containing phosphoric acid, good food, healthy surroundings, sea air, and similar therapeutic and hygienic agents are essential factors in the management of tuberculosis in bone. Even stimulants may be required. Antisyphilitic remedies are often required in full and long-continued doses, but combined with tonics.

In the early stages while the disease is active, cleanliness, disinfection of the parts, and the prevention of external sources of irritation or infection are the indications for local treatment. Rest of the parts, complete and constant, is imperatively called for, especially when the vicinity of a joint is affected. This is to be obtained by preventing motion by means of gypsum or silicate of sodium splints, by permanent extension, and similar mechanical appliances. This does not necessarily imply that the patient must be kept in the house or in bed. Confinement is often deleterious while open-air exercise is valuable.

When liquefaction of the tubercle occurs free incision should be made for the escape of the fluid, and the whole of the diseased and softened

bone should cut away with gouges. This should be done antiseptically and the resulting cavity dusted with iodoform. When the cavity is inaccessible or very large it may be injected with solution of iodoform in ether (1 : 20). Of this from 1 to 3 fluidounces should be used and then squeezed out after it has been brought in contact with the whole interior of the cavity in the bone and soft parts. The possibility of iodoform poisoning must be recollected, if large quantities are used in cavities, such as those of psoas abscess, where it is difficult to press out the excess of fluid.

Cure can often be hastened by the early operative removal, even before liquefaction has occurred, of the soft, devitalized bone and fungous granulation tissue, which impede repair. Natural processes can effect the removal of this material only after the lapse of many weeks or months, and the protracted discharge necessitated not only debilitates the patient, but has a tendency to cause waxy degeneration of the liver and kidneys. Sulphuric or hydrochloric acid diluted with equal parts of water has been recommended to dissolve away the softened bone. It may be injected into the sinuses or brushed upon the surfaces exposed by a flap incision.

If the bone can be reached by incisions not too extensive, scraping away the spongy and devitalized osseous tissue, and the fungous granulations, is more prompt and sure. To do this effectually Esmarch's apparatus should be applied to prevent hemorrhage obscuring the view. With a gouge, chisel, scraper, or the rotating burr of the surgical engine the surgeon removes the unhealthy structures. The operation should be discontinued when healthy bone is reached, which is recognizable by its comparative hardness, and the hemorrhage occurring from its surface. When the healthy bone is of nearly the consistency of the diseased parts it can be recognized by the pink color due to its vascularity. The carious bone when washed with water will be white, gray, or black. The possibility of general tuberculous infection from the tuberculous area leading to acute tuberculosis and death, is a factor strongly pointing to operative removal of the local tuberculous focus when it can be readily and safely done.

In extensive caries, excision, arthrectomy, or amputation may become necessary, but these capital operations should not be done hastily, since caries is a disease of chronic type. The lapse of a few months devoted to a general constitutional treatment and local measures may change a hopeless looking limb or joint into one that will be much more serviceable than any artificial one. The possibility of fatal exhaustion from the long train of progressive bone disease may lead one to amputate at a rather early date. Passive motion of joints affected with tuberculosis may be cautiously begun, when cure seems to be fully instituted by the absence of heat, pain, and discharge, and even when some discharge is present, if it is small in amount.

While believing that tuberculosis of bone or other tissues may be the local disease from which general infection of the patient may occur, I am still sure that cure of the local disease and subsequent freedom of the patient from other tubercular infections are not infrequently obtainable without operation. It is here that good judgment and experience are valuable.

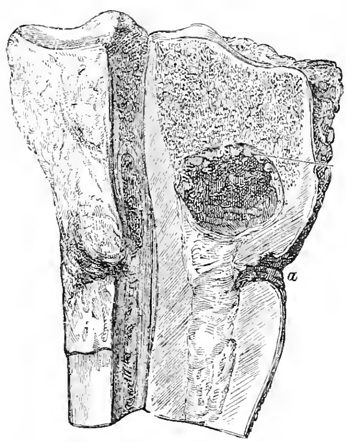
Central Caries or Tubercular Abscess of Bone.

The process usually called circumscribed "suppuration" of osseous tissue, or "bone abscess," is probably more common than is usually sup-

posed. Such collections of puriform fluid are instances of caries and are probably always due to the tubercle bacillus. They may occur in any part of a bone, but are more common in the cancellated structure of its extremities. The head of the tibia is the common site. These tubercular collections within the structure of the bone must not be confused with abscess in the medullary canal and suppurative osteomyelitis, which is a different pathological condition. The cavity may be lined by a soft membrane, or its walls may be roughened carious bone. Sometimes there is a narrow track or sinus leading from the cavity to the exterior of the bone, which in such a case would possibly have a carious surface; but often the pus is completely enclosed in a bony prison. The symptoms are usually very chronic in their progress and resemble those of ostitis, which is to be expected, as so-called abscess is merely a consequence of tubercular ostitis. Long-continued osseous pain distinctly localized, especially if near the extremity of a long bone and severe, should always suggest abscess. Circumscribed myelitis, necrosis, and cysts within the bone structure may give somewhat similar symptoms, but the treatment is similar in all these conditions and a differential diagnosis is not very important. Accompanying periostitis may add its symptoms to those of bone abscess.

Treatment affords prompt relief from pain, and consists in dissecting up the soft tissues and periosteum and applying the trephine to the bone at the most tender spot, so as to open the cavity, to give vent to the puriform fluid, and to permit curetting of the interior. If the inner surface of the wall is carious, it should be cut away with the gouge or burr; if necrosis exists the sequestrum should be removed. If no pus-like fluid is found the trephine may be applied at another spot, or better, perhaps, a drill may be made to perforate the bone in various directions from the bottom of the first trephine hole.

Fig. 135.



Bone abscess in which trephining was done; but the abscess was not discovered at the operation. *a*. Trephine wound. (Packard.)

Trephining should always be done early, as it is at once followed by cure if a puriform collection is present. If no fluid is present the operation does no great harm, and will probably ameliorate symptoms by decreasing tension. If no collection of pus-like fluid is found in the body of the bone it is well to bore into the marrow cavity before desisting, as it is possible that a chronic medullary abscess may be the cause of the symptoms. The wound is to be well drained and dressed antiseptically.

A "bone abscess" may open spontaneously into a neighboring joint, causing arthritis. This is another reason for early operation. Acute abscess of the medullary canal, or acute infective osteomyelitis, has been discussed in the preceding section.

Epiphysitis.

Inflammation of the cartilage situated between the shaft of a bone and its epiphysis occurs at times in children, especially in those of low vitality. The inflammatory bone conditions already discussed are apt to be associated with epiphysitis, though it is possible that it may be primary in its origin. The symptoms are similar to those of periostitis and arthritis, except when separation of the epiphysis and the preternatural mobility and crepitus there evoked show the loss of the uniting cartilage. Close scrutiny will usually prevent confounding epiphysitis with arthritis. The symptoms, prognosis, complications, and treatment are similar to what has been detailed in the consideration of ostitis. Early and free incision, even if no pus is suspected, is good surgery. Even those cases that recover without extensive destruction of tissue are apt to show subsequent arrest in development of the bone, because the osteogenetic function of the cartilage has been impaired. Tonics and nourishing diet are necessary in all cases.

Hypertrophy and Atrophy of Bone.

General increase of a bone in length and thickness, to which the name hypertrophy is often applied, is in most cases an inflammatory enlargement due to chronic ostitis, periostitis, and epiphysitis. Even after the inflammatory process has subsided the bone retains its increased dimensions. This is not hypertrophy in the true pathological sense. Hypertrophy may occur, however, when unusual functional demands are made upon a bone. An instance is seen in the increased size and strength of the fibula occurring when the tibia has been destroyed by necrosis.

Fig. 136.

Senile atrophy of head and neck of thigh-bone. (Gross.)

The fibula, being gradually called upon to support unaccustomed weight, becomes hypertrophied from increased functional activity. A localized increase in bulk of a bone is more properly called an osteoma or bony tumor. Hypertrophy of bone in itself neither demands treatment nor is amenable to it. Exostoses and other forms of osteoma may be excised if disfigurement or other reasons make operative treatment desirable.

Atrophy of bone is said to occur in two forms, in both of which there is decreased weight. In one variety the bone becomes smaller in size, with simultaneous absorption of the cancellated and compact tissue, and diminution of the calibre of the medullary canal. This change occurs after long disuse, as in stumps after amputation, and in joints where ankylosis, dislocation, or paralysis has long existed. It is observed most frequently in the long bones, and is a not uncommon senile change, which, when occurring in the neck of the femur, may produce shortening of the limb

and lameness, and thus simulate fracture at that point. As such localized atrophy, which is frequently associated with fatty degeneration, may happen after injuries, the practical knowledge of this possibility is great. Some cases of so-called atrophy of bone may be imperfect development, due to unrecognized or forgotten injuries or disease of the epiphyseal cartilages in early life. In the other form of atrophy the bulk of the bone is not altered, but the compact osseous tissue gradually becomes rarefied and changed into cancellated structure, whereby the bone becomes very light and brittle, and is easily broken by slight injuries.

The distinction between atrophy on the one hand and interstitial absorption and fatty degeneration of bone on the other hand is perhaps not sufficiently observed. The absorption of bone or rarefying ostitis due to pressure of tumors, for example, does not appear to be an instance of atrophy in as true a pathological sense as the disappearance of the alveolar process of the jaw after loss of the teeth. It is true that in the former case the thinning and erosion may be due to interference with circulatory and nervous supply, causing atrophic change; but the diminution of structure following disuse corresponds more nearly with the idea of atrophy.

Treatment is of no avail in curing osseous atrophy. In cases where the function can be restored, as in ankylosis of long duration, the bone may, however, regain some of its lost bulk.

Osteomalacia. Softening of Bone.

This very rare affection, also called mollities ossium, seems to be a general disease, though the chief changes are found in the skeleton. Its nature is exceedingly obscure. Some authors have suggested a possible identity with fatty degeneration, malignant degeneration, or atrophy of bone. Others have called it rickets of adults, since it resembles rickets, but has been observed only in adults.

The clinical characteristic of the disease is progressive softening of the bones, which become so soft that a knife can readily cut them. At the same time they lose weight and are either flexible or easily broken. Various portions of one bone, and as a rule many parts of the skeleton, are affected. The external compact portion becomes little more than a thin shell, while the cancellated structure has become more spongy than normal and filled with a reddish, gelatinous, fatty material. The earthy constituents of the bone have been removed by a process of decalcification, and a sort of mucoid degeneration of the animal portion of the osseous structure has apparently occurred. The medullary tissue is at the same time very vascular. Lactic acid has been described as found in the bony tissue and in the urine.

Osteomalacia is more frequently seen in women than in men and seems to be induced by pregnancy. It is a disease of adult life. The prolonged administration of lactic acid has been mentioned as a possible cause.

The symptoms are pain of a rheumatoid character and a tendency of the bones of the extremities or trunk to bend like softened wax. If the compact outer tissue of the bone is not much decalcified, however, brittleness instead of flexibility will be present and fractures from slight injuries will frequently occur. The urine usually contains a remarkable amount of phosphates, evidently derived from the degenerating bone tissue.

Phosphates have been found also, it is said, in the saliva, tears, and other fluids. Albuminuria has been observed. The patient finally becomes bedridden, because locomotion is impossible, and dies exhausted. Osteomalacia, unlike rickets, is painful, never occurs in children, and progresses until death occurs. The softened bones of rickets usually become hard again; such is not the case in osteomalacia. There is no efficient treatment known. Phosphates of lime, sodium, and potassium with cod-liver oil and tonics should be administered. Bedsores should be expected, and prevented if practicable.

Tumors in Bone.

Bones may become the seat of tumors of various kinds, such as sarcoma, osteoma, chondroma, fibroma, angioma, myxoma, and hydatid cysts. It was formerly believed that carcinoma was a not infrequent growth in osseous tissue. Such is not the fact. Except when it occurs secondarily to carcinoma in other structures this form of neoplasm is practically unknown in bone. Sarcoma, however, is common. True cystic tumors are seldom found except in the jaw bones, where they are at times developed from the mucous membrane of the antrum and the structures about the teeth. Tumors containing fluid found in other bones, unless hydatid cysts, are, as a rule, sarcomas, chondromas, or myxomas which have undergone cystic degeneration. Vascular tumors, that is to say, angiomas, are occasionally seen; but the pulsating tumors formerly described as aneurisms of the arteries in bone are probably always highly vascular sarcomas.

Tumors of bone may be developed from the lower layer of the periosteum or from the medulla or endosteum. Periosteal growths are usually oval or pyriform in shape, of a smooth surface, and have a capsule derived from the periosteum. The adjacent bone may be normal, hardened, absorbed, eroded, or fractured. The growth, if malignant, may spread to the medulla by the Haversian canals. Endosteal or central tumors are usually spherical, smooth on the surface, and when handled may give rise to a crackling sound. The enlargement of the growth causes disappearance of the bone, but the periosteum becoming inflamed constantly forms new layers of bone tissue. These are absorbed in turn, but new plates of osseous tissue are continually developed. Thus the mass acquires a more or less bony capsule, and when the patient is examined a crackling sound is elicited by the motion imparted to the membrano-osseous encasement. This is the explanation of the apparent dilatation of the bone and the parchment-like crackling elicited by pressure.

Non-malignant growths in bone do no harm, as a rule, other than to act as impediments to motion, and to cause deformity. They may be excised with chisels and saws if such action is demanded by the disability or disfigurement. Sarcomas spread into the surrounding parts and involve distant structures by secondary involvement through the blood-current. Amputation, early and at a considerable distance above the disease, is always demanded.

Injuries of Bones.

Bone, together with its periosteum and marrow, may receive contused, incised, lacerated, and punctured wounds. Such wounds of bone are frequently obtained in war from bullets, balls, sabres and arrows, and occasionally are seen in civil practice. Fractures are lacerated wounds of

bone, and are common everywhere. Osseous wounds are followed by periostitis, ostitis, and osteomyelitis, which may be localized or diffused. The wounds should be treated as similar wounds of soft parts and their sequences on the principles detailed in the section on diseases of bone. Fractures, which are wounds or solutions of continuity, usually involving the entire thickness of the bone injured, will be discussed in the following section of this treatise. Contusions of bone may become of grave import, when a viscus, such as the brain, within the bony case, is simultaneously or secondarily involved, or when atrophy of the bone, as in the neck of the femur, is so induced. The induction of osteomyelitis by contusion is another serious complication of what may seem a trivial injury.

Bending without fracture occurs at times in very young bones or in those softened by rickets or osteomalacia. The treatment is to bend them forcibly into proper shape, or to do so gradually by means of well-padded splints or the elastic tension of rubber straps. Muscular action or the elasticity of the bone may correct such deformity in children without much treatment. The surgeon should not hesitate to straighten such bones by making a complete fracture if there is a probability of permanent deformity.

Fractures.

Definition.—A fracture is a sudden breaking or tearing apart of osseous fibres; in other words, a lacerated wound of bone.

A solution of continuity due to disease or to division by saws or sharp instruments is not a fracture, though in its treatment and mode of repair it may be similar. The term fracture is also applied to breaking of cartilaginous tissue.

Causes.—For the production of a fracture an exciting cause must always be present, but certain characteristics of the patient or of the special bone may act as predisposing causes. The atrophy of bone occurring in old age and in the subjects of locomotor ataxia, osteomalacia, rickets, and malignant diseases of bone, are efficiently predisposing causes, for they render the bony tissue less able to resist strain. Syphilis and tuberculosis have been called predisposing causes, but probably on insufficient evidence. General paralysis of the insane seems to be associated with brittleness of bones. This is probably due to atrophic changes in the osseous structure. Stimson states that the greater fragility of bone in the aged is to be attributed to senile atrophy, and not, as is often asserted, to a greater relative proportion of inorganic material. A bone, by reason of its exposed position, its curves, its function as a lever, or its small proportion of compact osseous tissue, may be more liable to suffer fracture than the adjacent pieces of the skeleton. On the other hand, a flat, movable bone, surrounded by muscles, such as the scapula, is very unlikely to be broken.

The exciting causes of fracture are external violence and muscular action. External violence is said to act directly when the bone is broken at the point of impact. It is a crushing force that causes disruption of the osseous fibres in these cases. Gunshot fractures and fractures caused by kicks and by falling timbers are thus produced. External violence is said to act indirectly when the fracture occurs not at the point struck, but at some distant part of the skeleton. The force is transmitted thither through the intervening bones, and tears the bony fibres apart by leverage, torsion or traction. Muscular action is not a very frequent cause of

fracture except in fracture of the patella. That powerful muscular contractions may cause fracture of long bones is proved by instances occurring in athletic persons during efforts of throwing or lifting. Similar injuries have been reported as taking place during tetanic or epileptic spasm of muscles. Fracture of the patella, olecranon, of the posterior end of the calcaneum and of the coracoid process of the scapula is usually due to powerful muscular action.

Breaking of the patella by contraction of the four-headed extensor of the leg may possibly be at times rendered more easy on account of leverage action exerted upon the bone as it lies in contact with the condyles of the femur. Stimson, however, believes that it is usually a giving way, as a rope, from direct traction, exerted by the muscle. The muscles, by holding the bones in fixed positions, may indirectly assist external violence in causing fractures. This will be understood by considering that a cadaver thrown from a height is less likely to sustain fracture than is a living body.

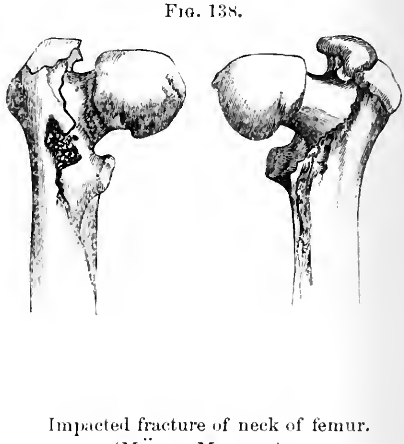
Fractures occasionally take place in the uterus; due usually to violence inflicted upon the fœtus by injuries received upon the abdomen of the mother. A rachitic fœtus is prone to suffer such osseous lesions from comparatively slight force. It is possible, however, that some supposed intra-uterine fractures are really instances of defective ossification.

Varieties.—There are two kinds of fractures; the open and the closed. The open fracture is one in which the broken surfaces are exposed to atmospheric contact by reason of a communication with the

Fig. 137.

Diagram of comminuted fracture.

Fig. 138.



Impacted fracture of neck of femur. (Mütter Museum.)

surface through a wound of the muscles, fascia, and skin. A closed fracture is one with which no such wound coëxists, and which is therefore protected from atmospheric influences. The former are often called compound fractures; the latter simple fractures. As these terms are not

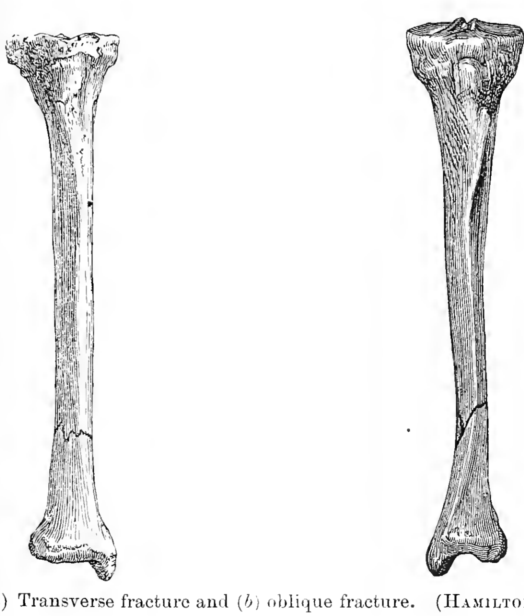
self-explanatory and are otherwise objectionable, they should be discarded. Closed fractures are sometimes denominated subcutaneous fractures. This use of the word, though convenient, is misleading, because it seemingly implies that the fracture is an open one whenever the skin in the vicinity of the fracture is laid open. Such is not the fact. Communication with the air is the requisite of an open fracture; hence the muscles and fascia, as well as the skin or mucous membrane, must be perforated or divided.

The open character of a fracture may be due to the vulnerating force causing laceration of the soft parts, to its continuance inducing protrusion of the fragments, to the weight of the unsupported limb giving rise to a similar protrusion, or to secondary ulceration and suppuration.

Open fractures are much more serious than closed fractures, because pyogenic bacteria gain admission to the wound and suppuration generally occurs about the ends of the fragments. Union is, therefore, less rapid, and osteomyelitis of a severe type and septicæmia are more likely to arise. The modern or antiseptic methods of surgery have rendered open fractures as little liable to these complications as were closed fractures formerly.

FIG. 139.

a *b*



(*a*) Transverse fracture and (*b*) oblique fracture. (HAMILTON.)

Various terms are applied to both open and subcutaneous fractures to indicate the characteristics of the broken structure: A comminuted fracture is one in which several inter-communicating lines of fracture split the bone into a number of comparatively small fragments. If a bone is broken at two or more different places and the lines of fracture do not run into each other, the injury is a double or triple fracture, not a comminuted one.

In an impacted fracture one fragment is driven into the cancellated

structure of the other and firmly fixed there. It is rather rare, and can only occur, as a rule, at the extremity of bones where there is much cancellated tissue. The lower end of the radius and the neck of the femur are the localities in which it is likely to be seen.

In a transverse fracture the plane of fracture makes a right angle, or at least an angle of not less than 70°, with the long axis of the bone. Transverse fractures are rare, except in the patella and at the lower end of the radius, and when observed are usually caused by either direct violence or muscular contraction. They are probably more common in children and the very aged than at other periods of life.

Fig. 140.

Longitudinal fracture. (Stimson.)

Fig. 141.

Incomplete fracture of femur. (Gurlt.)

Longitudinal fractures are those in which the line of fracture is not further from the long axis of the bone than 15° or 20°. They are very rare, except as accompanying such perforating fractures as are caused by gunshot injuries.

Oblique fractures are those in which the line of separation is neither transverse nor longitudinal. The majority of fractures are oblique.

A complete fracture of a long bone crosses the long axis of the shaft and divides the bone into two or more pieces. A fracture of a flat bone to be complete must involve its entire thickness. Under the head of incomplete or partial fractures of long bones are included the so-called "green-stick" fractures, in which some fibres are torn and others bent, fissures, separation of mere splinters, detachment of bony prominences, and perforating fractures, such as are made by bullets. Indentations of flat bones by forces not sufficient to cause fracture through the entire thickness, are instances of incomplete fracture.

Incomplete fractures may become very serious injuries; for example,

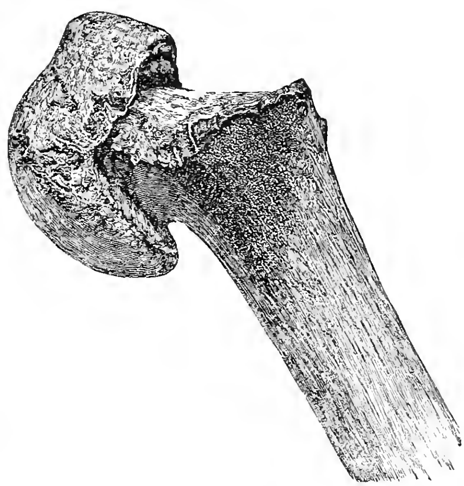
fissures communicating with the marrow, if open to the external air and infected with putrefactive or pyogenic germs, may be followed by dangerous osteomyelitis. The injury sometimes called "sprain fracture," in which a small fragment of bone is torn away at the point where a ligament is attached, is an incomplete fracture. Rupture of the main artery, laceration of the chief nerve, extension of the line of fracture into a joint, dislocation, and other lesions may occur simultaneously with a fracture and complicate the treatment.

A diastasis, or forcible separation of an epiphysis from the shaft of a bone, presents the symptoms of a fracture, and requires like treatment. Ossification of all the epiphyseal cartilages has usually occurred before the twenty-fifth year; hence epiphyseal fracture or separation can rarely happen at a later period of life than this. The line of separation is of necessity usually transverse: and commonly some scales of bone are torn from the shaft with the layer of cartilage. The innominate bone may be separated by injury into its three primary segments by a similar separation through the cartilages. Arrested growth is not unusual after epiphyseal detachments.

FIG. 142.

Fissure of humerus. (GURLT.)

FIG. 143.



Diastasis, or epiphyseal separation of the head of humerus. (MOORE.)

PATHOLOGY.—When a bone is broken hemorrhage occurs from the arteries and veins in the Haversian canals and medullary cavity, and the periosteum is more or less extensively lacerated. The muscles and fascia about the seat of fracture are usually implicated in the violence, even in closed fractures with little displacement; hence extravasation of blood in and from the surrounding soft parts is common. The blood from the torn soft parts usually shows as a blue discoloration of the skin a few hours after the injury. That effused from the osseous structure itself does not reach the surface for two or three days, because it can only leak through the

deep fascial coverings by means of small openings existing where nerves and bloodvessels approach the exterior. By gravitating or travelling under fascial or muscular layers it may appear quite far from the locality of fracture.

The periosteal laceration may correspond with the line of fracture, but this is uncommon, because the majority of fractures are oblique, and in them the periosteum is apt to be stripped up from the bone in the vicinity of the fracture before it gives way under the tension of the disrupting force. This renders the line of tear irregular. In comminuted fractures some of the fragments may be held in position by untorn periosteum, while others are entirely denuded of this membrane. The latter are not apt to become necrotic unless the wound is infected with micro-organisms. Very occasionally it happens that a bone is broken and the periosteum left intact or nearly so. Little displacement then occurs and rapid cure without deformity is to be expected.

Around the locality of fracture inflammatory processes at once occur, varying in intensity with the severity of the damage done to the bone and the soft parts. The interference with return circulation caused by the pressure of the inflammatory products may give rise to œdema of the distal portion of the limb, even in cases of fractures of very moderate gravity. The fever and other general symptoms depend on the type and degree of the inflammatory action. Albumin, tube casts, and fat have been observed in the urine of patients suffering with fractures, apparently as a sequence of the osseous injury.[1]

The fragments of bone, except in cases of mere fissure, seldom retain their normal position. Continuance of the injuring force for a moment after the disruption of the bone has occurred, attempts to use the injured member, as in walking, dropping of the unsupported limb below the injury because of its intrinsic weight, and tonic or spasmodic muscular contraction are all displacing causes. Fractures in children show less displacement than those in adults, because greater elasticity of the bone makes the line of fracture more irregular and therefore the fragments are more apt to remain interlocked. Moreover, the periosteum is less completely torn and the muscles are less powerful.

Angular, rotary, transverse, or longitudinal deviation may occur at the seat of fracture. Usually, however, the displacement is a combination of these malpositions. Occasionally, as in some comminuted fractures, the displacement is too complex in its nature to be classified under these heads. As a rule, it is the distal fragment that occupies the abnormal position. Transverse fracture of the patella, fracture of the olecranon, and similar injuries afford exceptions to this rule. Angular displacement or tilting, in which the axes of the fragments form an obtuse angle, is typically represented in green-stick fractures and bending of bones, in which, indeed, it is the only form of malposition possible. In rotary displacement one fragment is twisted on its long axis. A good example is fracture of the shaft of the femur in its upper third. Here the weight of the limb usually rotates the lower part of the bone outward. When one fragment is displaced laterally or antero-posteriorly, transverse deviation exists. This form of displacement seldom happens except in combination with one of the other varieties. It may occur alone, however, in transverse and serrated fractures. If the ends of the fragments slip

[1] Riedel, quoted by Stimson, Treatise on Fractures, 111.

past each other the muscular tonicity causes overlapping, unless an unbroken parallel bone, as in the leg or forearm, prevents its occurrence.

Fig. 144. Fig. 145. Fig. 146. Fig. 147.

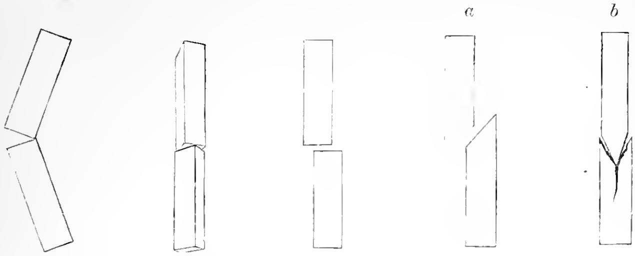


Fig. 144.—Diagram of angular displacement.
Fig. 145 —Diagram of rotary displacement.
Fig. 146.—Diagram of transverse displacement.
Fig. 147.—Diagram of (*a*) longitudinal displacement; (*b*) impaction.

Longitudinal displacement is a change made in the long axis of the bone. It consists in overlapping of the fragments, in penetration of a broad fragment by a narrow one (impaction), or in actual crushing of the osseous structure into small pieces. In rare instances, as in fracture of the patella and olecranon, the longitudinal deviation consists in separation of the pieces of bone. This is dependent upon a powerful muscular attachment to one of the fragments. Muscular action in nearly every other fracture causes shortening. It is not always possible to predict the character and extent of displacement that will occur in a fracture at a given locality, for it depends on the direction and nature of the line of fracture as well as on the muscular attachments and other above-mentioned causes of deformity. All the forms of displacement occur in a marked degree in oblique fractures, while little deviation is seen, as a rule, in transverse ones.

Symptoms.—A case of suspected fracture should be examined as soon as practicable after the receipt of the injury, unless the intensity of nervous collapse or some similar circumstance makes such examination more hurtful than a few hours' delay in determining the exact character of the injury. When a case is not seen until some days after the accident and very violent inflammation has already supervened, it may be wise to wait a day or two and endeavor to lessen the inflammatory symptoms before undertaking the manipulations necessary to establish an accurate diagnosis. In obscure cases anæsthesia should be induced that a thorough examination may not be prevented by reason of pain. In order to give the patient time to recover equanimity after the surgeon's entrance, as well as to learn the facts of the case, questions concerning the accident should be asked before the examination is begun. If this is not done the nervous excitement due to pain from the examination or the insensibility of anæsthesia will make the obtaining of definite answers impossible. The possibility of deformity from previous injuries and the history of the case should be fully considered. The surgeon should then grasp the parts firmly and examine carefully and thoroughly for deformity, abnormal mobility, crepitus, and any other objective symptoms necessary to establish a diagnosis. Needless repetition of movement is to be deprecated as much as inefficient firmness of grasp during the manipulation is

to be avoided. A wound near the seat of fracture should be cautiously explored with the finger and probe to see whether the fracture is an open or closed one. If oil globules escape from the wound within twelve hours the wound probably connects with the fracture. It is the injured marrow that furnishes this fat. A good deal of venous oozing is also suggestive of the fracture being an open one, because the veins of soft tissue cease bleeding sooner than those of bone. The latter cannot collapse so readily.

The symptoms, which, when occurring together, make the evidence of fracture conclusive, are: deformity, abnormal mobility, and crepitus or grating. One is often sufficient to establish the diagnosis, but their coexistence is pathognomonic. If one of these symptoms gives unmistakable evidence of fracture, it is often well to desist from endeavors to develop the others, since such action but adds to the pain, and may increase the displacement of the fragments. In many fractures one or two of these symptoms, as will be shown subsequently, may be absent.

Deformity is principally due to the displacement of the fragments. Extravasation of blood may aid in the primary deformity, and inflammatory swelling in that which occurs later. The forms of displacement, which have been already discussed on a previous page, may give rise to marked or very slight deformity. Slight deformities are often, however, much more difficult to correct than great ones. When the periosteum is slightly torn there is no deformity, because this fibrous membrane retains the fragments in apposition. Mere fissures give rise to no deformity. The recurrence of deformity, when external restraining forces are relaxed, is a characteristic of most fractures, serving to differentiate this class of injury from dislocation of joints. In estimating the degree or existence of deformity, previous fractures and injuries, periosteal nodes, exostoses, and shortening from old joint inflammations, or contracted tendons, must be eliminated. Sprains and dislocations often give distortions similar to fractures near corresponding joints, and must be discriminated by other symptoms. The two sides of the body should always be compared with the bones in exactly the same position. Angular and rotary displacement are generally easily recognized; but shortening due to overlapping is often difficult to verify, because accurate measurement is almost impossible. The bony prominences taken as standards of comparison are rounded, therefore the tape-measure can seldom be stretched between exactly corresponding points. Another element of doubt is the well-known normal inequality in length of bones of the two halves of the body. Shortening in very oblique fractures, as of the thigh, may amount to several inches.

A clot of blood, a limited condensation by crushing, or a localized swelling of the soft tissues, sometimes simulates deformity from displaced bone. This is a frequent source of error in head injuries. A long needle thrust through the skin and muscles will, by impinging on the hard bony structure, clear up this uncertainty in some cases. In fractures involving joints the peculiar deformity due to the synovial sac being filled with blood or inflammatory products may aid in proving the existence of a fracture.

Preternatural mobility after injury is absolute proof of a fracture, except in those rare instances where dislocation with very great tearing of the ligaments allows unusual motion at a joint. Increased mobility is sought for by endeavoring to move one part of the bone independently of the other, and so to produce angular, rotary, or transverse deformity at the seat of injury, or shortening or elongation of the bone or entire limb.

The best method of developing these features is to hold one extremity of the bone immovable, while an attempt is made with the other hand to move the other extremity. If preternatural local motion can be obtained, and it is usually shown by the production of the deformities mentioned, the existence of fracture is undoubted. Absence of mobility must not be asserted until endeavors have been successively made to lengthen, shorten, bend, and rotate the bone at the seat of supposed fracture, because sometimes the line of fracture is such that only one direction of force will develop the abnormal mobility.

When the injury is near a joint where motion is a normal condition, when the bone is so short or so deeply located that its two ends cannot be firmly grasped, and when, as in the case of the ribs, sternum, and fibula, considerable normal elasticity exists, which, upon manipulation, can simulate mobility, it is difficult to be certain that preternatural motion is present. Swelling also may sometimes prevent a just appreciation of the existence of mobility. Fractures, moreover, may exist with little or no increased mobility of parts. Such is the case in impacted, in partial, and in interlocked toothed fractures. When one of two parallel bones is broken, the mobility is often slight. When the shaft of a bone is broken near the middle, the unnatural seat of motion may be sufficiently demonstrated by merely placing a hand under the limb and endeavoring to lift it upon this single point of support. Motion and consequent angular distortion are at once evident. In searching for motion by rotation the fragment moved should be twisted but slightly, since the muscles may connect the fragments sufficiently closely to cause the rotation to be transmitted to the fixed fragment when any considerable degree of rotary movement is attempted.

When a bone is intimately associated with and held quite fixed by other bones, alternating pressure with the thumbs or fingers applied on each side of the point of injury may develop motion. This method is especially applicable to the fibula and the ribs. In transverse fractures motion will be developed best by force applied laterally, and in oblique fractures by forces tending to elongate or shorten the bone in the direction of its long axis.

Crepitus is the grating sensation felt by the surgeon when he rubs the rough surfaces of the broken bone together. There is often some noise produced by this manœuvre, but the diagnosis rests more on the vibrations conducted along the bone to the hands of the surgeon than on any noise appreciated by his ears. Mobility and grating are usually, though not always, coexisting symptoms. Grating cannot be felt without moving the fragments, but motion may sometimes be produced without making any grating sensation or crepitus perceptible. The development of crepitus requires that the surfaces should be rough, and that they should be sufficiently in contact to render friction of one surface upon the other possible. If the ends are separated, as in fracture of the patella; if they greatly overlap so that the smooth surfaces of the sides of the bone are in contact; if portions of muscle, periosteum, or fascia lie between the pieces; or, if the broken surfaces have by lapse of time become covered with granulation tissue, the surgeon will fail to observe distinct crepitus until he alters these conditions. No grating is possible as a symptom of impacted or green-stick fracture unless the parts are previously rendered movable. Sometimes a certain manipulation will give rise to distinct crepitus, but afterward will utterly fail to produce a similar result. This

is because by reason of muscular or external forces a different relation of the fractured surfaces has been assumed in the interval.

To elicit grating the surgeon manipulates the parts in such a manner as to produce motion. In fact, preternatural mobility and crepitus are demonstrable at the same time and in a similar manner.

When possible, it is best, perhaps, to move the two fragments in opposite directions, as this gives a greater degree of friction. When there is much overlapping extension must be made before grating can be felt. Placing the palm of one of the hands over the seat of injury is sometimes a good method of feeling grating in bones that are not easily grasped with the fingers. Motion is then obtained by the other hand alone. This often avails in fracture of the neck of the femur or great trochanter, or in rib fractures. In the last the proper motion may at times only be obtained by deep inspiration or coughing. If the limb is heavy, an assistant may steady or move one portion of the bone while the surgeon has hold of the other. In most cases the surgeon is able to control both parts with his own hands. When the presence and character of crepitus have once demonstrated the existence of fracture, no further manipulations should be attempted. The character of grating varies with the character of the fracture. It may be a single slip or snap, or it may resemble the sensation perceived when two pieces of roughened dry wood are rubbed together with the hands. In greatly comminuted fractures the sensation imparted is that of motion among a number of loose pieces of hard material. If any sound is heard at the same time it will similarly be a sharp click, a dull, muffled scraping, or an irregular crackling. The character of crepitus, however, will not always give a correct idea of the nature of the fracture. A sensation of loose grating may be felt when the bones are held closely together. The best manner of conveniently illustrating the peculiar sensation called crepitus is to take an animal's bone, obtained from the markets or elsewhere, and after wrapping it tightly in a towel to break it. Motion of the fragments in various directions will give almost typical grating.

Fracture crepitus may be confounded with, and, therefore, must be distinguished from the friction-grating of diseased joint surfaces and that of a dislocated bone rubbing on the periosteal surface of another bone. It may also be simulated by the fine crackling of inflamed tendons and bursæ, that felt and heard in subcutaneous emphysema, due to puncture of the air-passages or decomposition of cellular tissue, pleuritic or pulmonary sounds, and the crackling of coagulated blood in the tissues. Joint grating is said to be finer and moister than fracture grating, but sometimes it is impossible to assert with positiveness which kind of crepitus is present. Those conditions giving impressions similar to fracture crepitus can usually be eliminated by collateral evidence if the surgeon merely recollects the possibility of their existence. A piece of necrotic bone may give rise to sharp grating sensations and sounds, if in a position where another piece of bone can rub against it.

A curious fallacy is this: that occasionally the crepitus perceived appears to be developed in a certain bone when it is really due to fracture of a contiguous part of the skeleton. Direct auscultation over the seat of suspected fracture, either with or without a stethoscope, is probably of little value, because the sensation of rubbing, rather than the sound, is the important diagnostic feature. Perhaps auscultation may be applicable and serviceable in fractures of the ribs and sternum.

The grating produced by motion of the fragments is frequently perceptible to the patient. Occasionally a giving-way sensation, accompanied

by a sharp crack, is noticed by the patient at the time of the accident. A similar symptom is liable to occur, however, when a tendon is suddenly torn, or when a dislocation with great ligamentous laceration takes place. Hence, this snap, even when noticed, has little diagnostic value. It is more often observed by the patient in fractures from muscular contraction than from violence.

The characteristic symptoms of fracture, then, are deformity, preternatural mobility, and crepitus. Pain, ecchymosis, loss of function, and a variety of other symptoms may be present, but they also exist in such diverse lesions that they have, as a rule, no diagnostic value.

A persistent tenderness after injury limited to a small area of bone is, however, very suggestive of fracture without displacement. The opinion of the laity, that pain in fractures increases when the fragments of bone are becoming united, is erroneous. Painful muscular spasms, due chiefly to irritation of the muscles by the sharp points of the broken bone, are frequently experienced in the early stages of fractures.

Swelling deserves little recognition as a symptom of fracture, but is a factor of very great importance in the determination of the best methods of treatment. When the inflammatory swelling is rapid, numerous vesicles may occur on the surface. These may be filled with bloody serum. It is well not to rupture them, as the blood is often absorbed quite rapidly. Intractable ulceration at times follows if the epidermis is rubbed off before new epidermis is formed beneath that which is pushed up by the fluid.

Ecchymosis about the seat of lesion is often due to mere contusion of the soft parts. If it first appears after the lapse of several days, and especially if the black-and-blue discoloration is found at some distance from the seat of injury, a fracture is probably present. This tardy appearance and distant location are due to the difficulty which the blood extravasated from the broken bone, periosteum, and marrow has in reaching the surface through the fascial layers. This slowly occurring ecchymosis, particularly when the swelling of the parts results in the formation of blebs on the surface, may be mistaken by the inexperienced for incipient gangrene. Absorption of this extravasation from the deep vessels is always effected in a tardy manner. Indeed, the fracture may be united before all the discoloration has disappeared.

Blood extravasated from large vessels may, it is said, cause synovitis by coming in contact with the outside of the synovial membrane. It is not essential that the synovial sac be perforated or ruptured. Rupture of a large artery as a complication of fracture is of grave import, because it gives rise to great extravasation in the tissues.

Loss of power of the part often occurs after fracture, sometimes from fear of pain, sometimes from loss of continuity in the bony lever. This symptom is absent in many cases of impacted, serrated, or partial fracture, and also in those in which the periosteum is slightly torn. Patients have walked considerable distances with a fracture of the femur or tibia. Motions which do not give pain at the seat of fracture, and which do not require rigidity of the particular bone that is broken, can be perfectly performed in nearly every case. Movement of the fingers, for example, is often unimpaired in fracture of the radius. When there are two parallel bones, one may serve as a support to that which is fractured, and thus prevent impairment of its ordinary functions.

Intermittent muscular spasms are often an annoying symptom of fracture. They are due to pricking of the muscles by the fragments, and to

general nervous excitability. Numbness and other nerve symptoms may be present from coincident injury to nerve trunks.

The constitutional symptoms of fracture, after the period of shock, are those of inflammation and its consequences. In an uncomplicated closed fracture there are scarcely any constitutional symptoms. A slight febrile rise is often noticeable, however, during the first three days. In open fractures suppuration is usual, unless care is taken to make the wound aseptic immediately after its receipt, and to keep it so during cicatrization. Open fractures, managed as described, are usually free from suppuration, and cause as little trouble as closed fractures of similar location and extent. Great debility, erysipelas, tetanus, fat embolism, septicæmia, and pyæmia may all be seen as sequences of fractures if they are not treated so as to be free from germ infection. In old age fractures may prove fatal from the consequent debility that is induced.

Diagnosis.—The symptoms described will usually render the diagnosis of fracture easy; but when deformity, preternatural mobility, and grating are not all found, or, if found, are not well marked, the true nature of the injury may be obscure. Especially is uncertainty apt to arise when the lesion is near a joint, for here there is a great deal of normal mobility, and joint-grating may, from some cause, be present. Careful examination under ether, with the corresponding healthy limb uncovered so that comparison can be made, will usually disclose the true nature of the lesion. Severe bruises can be discriminated from fractures in a similar manner.

Dislocations, because of the resulting deformity, may resemble fractures near joints, but in dislocations, unless there is unusual laceration of ligaments, the normal motions of the articulation are impaired; and the surgeon generally finds by manipulation that a sudden and abnormal check to free movement occurs in certain positions of the bones. This is not the case in fracture, for there the motion is almost unlimited. Again, in dislocations there is some resistance when an attempt is made to overcome the deformity by putting the parts in position, but when this has been accomplished there is little tendency to recurrence of distortion. In fractures, on the other hand, the deformity is remedied with ease, but the mere weight of the limb or a slight force will reproduce it. Voluntary motion is, as a rule, not so impaired in dislocations as in fracture, for the long lever is intact, and there is simply a change in the bearing-points of the articulation. Fractures have an appearance or "physiognomy" of helplessness; dislocations a "physiognomy" of rigidity. The normal relation of the bony prominences about a joint should be familiar to the surgeon, so that any deviation by dislocation or fracture may be detected. The various "test-lines" used for determining these relations will be spoken of in discussing fractures near special joints.

The diagnosis between a separated epiphysis and a fracture in the same region is often difficult; but it is not very important, since the treatment is identical. A separated epiphysis gives a smoother and less distinct grating than a fracture, and is apt to be followed by diminished growth in length of the bone.

More difficult than the determination of the simple existence of fracture is the localization of the exact position and line of fracture. This is often of importance, and may be determinable only by careful fingering, accurate measurements, and close observation of changes in relative position of the prominences. Oftentimes the exact line of break is only to be inferred.

The conduction of percussive vibrations from one end of a bone to the

other will at times prove the non-existence of a line of complete fracture between the two points. Let the examiner grasp or place his fingers on one extremity of the bone, and then give the other several quick, sharp blows with his finger-tips or a small hammer. If the vibrations are distinctly conveyed along the bone, complete or impacted fracture is improbable.

Prognosis.—Closed fractures, if uncomplicated, usually do well. Open fractures are more serious than closed fractures of a similar degree of bone injury, only when infected by putrefactive or pyogenic bacteria. Oblique fractures usually leave some shortening of the bone, though this may be very slight and scarcely noticeable. Fractures in children unite more rapidly than those in adults; and fractures of the upper more quickly than those of the lower extremity. Small bones become united sooner than large ones. Some permanent stiffness is the rule after fractures involving a joint. Many fractures will be followed by imperfect or bad results, notwithstanding the best surgical treatment.

It is a common mistake to suppose that when the bone becomes united the patient will at once have a normal limb. Stiffness of the articulations, a dry and rough skin, œdema and congestion, especially when the limb hangs down, and pain aggravated by changes in the weather are the most frequent sequelæ of fracture. Many months may pass before they all disappear. Sometimes one or more of these symptoms is permanent.

Stiffness, when not due to actual involvement of the articulation in the line of fracture, depends on the simultaneous occurrence of a sprain, hemorrhagic extravasation around or into the synovial sac, the entanglement of tendons in the ossifying callus, or retraction of the ligaments and peri-articular tissues during the period in which the joint was kept immovable by the fracture dressing. This joint stiffness subsequent to fractures is most marked and more persistent in old persons and those of a rheumatic diathesis.

Œdema results from pressure of the fragments or callus upon the deep veins, or from phlebitis and coagulation secondary to the injury. The coagula formed in the inflamed veins give rise in very rare instances to embolism. Sudden lividity or pallor, dyspnœa, precordial pain, and death occurring from three to six weeks after the receipt of fracture point to venous thrombosis and embolism. Less severe symptoms of the same character, followed by localized lung consolidation and cough, are due to detachment of a smaller embolus, and may terminate in recovery. If phlebitis is suspected, it is wise to keep the patient quiet and the limb at rest until absorption of the internal coagulum has occurred. Its fragmentary detachment from the walls of the vein is to be feared.

Cases of death after fracture have been attributed to what is termed fat embolism. It is supposed that the crushed marrow furnishes free fat globules, which, taken up by the veins and lymphatics, produce embolic plugging of the lungs, kidneys, brain, and other organs. The symptoms are similar to those of shock[1] and of the venous embolism; but occur later than the former, and earlier than the latter. Not immediately after injury, as are symptoms of shock, but after the lapse of one or two days have symptoms attributed to fat embolism been observed.

Death, it is said, may occur very promptly from obstruction of the pulmonary circulation by these fat emboli; or it may be delayed for a week or ten days and be due to inflammation of the lungs, brain, or kidneys, secondary to the embolic process. Some observers suggest that

[1] Holmes's System of Surgery: Packard's edition, vol. i. pp. 144 and 145.

traumatic delirium and hypostatic pulmonary congestion after fracture may be the result of fat embolism. Experiments show that disastrous results are only liable to occur when very extensive fat embolism is present. Otherwise the fat is eliminated, perhaps by the kidneys, for fat has been found in the urine. Subjects of chronic alcoholism and the aged are presumed to be specially liable to suffer severely from fat embolism, because the weakened heart cannot propel the fat circulating in the blood-current, nor are the damaged viscera able to resist the effects of the embolic injury. No secondary abscess occurs in fat embolism.

The indication of treatment is to prevent the occurrence of fat embolism by keeping the crushed limb quiet and avoid further laceration of the marrow. If amputation is demanded by the extent of the injury, it should be done promptly before much fat is absorbed. Intravenous injection of ether, as suggested by Packard, may perhaps be indicated.

Fractures may be complicated with, or followed by, dislocation, synovitis, gangrene, caries, necrosis, injuries to viscera, laceration of arteries, veins or nerves, and delirium. These circumstances greatly affect the prognosis. Whiskey-drinkers and the aged seem especially liable to traumatic delirium after fractures.

Repair of Fractures.

As has been shown is the section on healing of wounds, repair of most soft parts results in a cicatricial tissue which is analogous to, but not identical with, the structure wounded. In bones, however, as in nerves, a much more perfect regeneration occurs. Indeed, the uniting bone, if examined sufficiently long after the time of fracture, has the microscopic structure of true bone.

Bones are repaired by the same general processes as are other tissues. The cells of the periosteum and marrow, and those lining the Haversian canals and the lacunæ of the bone multiply. By this proliferation is formed a mass of granulation tissue, which fills the spaces between the pieces of bone and sometimes infiltrates the parts around the bone. This new material gradually becomes ossified by the deposition of earthy salts at numerous points, and the subsequent coalescence of these ossific centres. The time after fracture at which bony particles are first formed in the bond of union is probably two or three weeks. The transition from granulation tissue to bone is usually through the connective tissue stage; though occasionally the granulation material, at least in some parts, becomes cartilage before it is transformed into bone. Some of this new bone, which is at first spongy in structure, becomes compact; some of it becomes more rarefied, and some is entirely absorbed; until, finally, if the fragments have been kept in correct apposition, the bone is so well restored to its normal condition that, even when the dried bone is sawn open, no line of fracture can with certainty be distinguished. In fact, the changes occurring in repair of fractures differ only in a degree from those observed in the normal growth of bone. The location and degree of injury and the relative position of the fragments modify the number of Nature's resources, and change the character and amount of the reparative work to be done. Hence must be described more minutely the various steps of repair in closed, in open, and in epiphyseal fractures; and under closed fractures the differences between fractures of the shafts

of long bones or portions of bone with a medullary canal, and fractures running into joints.

After the shaft of bone is fractured the periosteum, torn and stripped up from the bone though it may be, often forms a sort of ragged sheath around the seat of fracture. Within the limits of this imperfect periosteal sheath new tissue to unite the bone is principally deposited. The periosteum, the injured marrow, and the broken cylinder of compact bone all become inflamed and furnish cellular elements, which, mingling with the blood-clots and effused serum, form an inflammatory exudate which becomes granulation tissue.

The bone is the least active and slowest in furnishing new tissue, because it normally has fewer cells of its own than the marrow and periosteum, but at length granulations appear on the ends of the fragments and finally coalesce across the gap. This granulation tissue filling up the space between the ends of the fragments and lying within the confines of the periosteum and other tissues surrounding the seat of fracture, has of course no firmness until ossification begins. When it begins to be firm it is called callus. During this early period of repair the connective tissue in the structures outside of the periosteum is also filled with proliferating cells, and thus steadies the broken bone by glueing the adjacent muscles, tendons, and fascias together.

The granulation tissue formed usually ossifies in man as connective tissue without showing any cartilaginous stage; but when fractures in man are kept perfectly at rest the granulation tissue which lies between the fragments and around the bone may become cartilaginous before being ossified. In any event it requires weeks for the callus to gain the hardness of bone. Ossification through the cartilaginous stage is the common event in the lower animals.

During this period the marrow callus, which has occluded the medullary canal like a plug, and the external callus have held the fragments firmly in position. These depositions go by the name of provisional or temporary callus. As the interosseous callus—that is, the callus between the two cylinders of bone, called the permanent or definitive callus—becomes hard, the external callus, as well as the internal callus which lies in the medullary canal, is absorbed. Thus the surface of the bone is finally given its normal contour, and the medullary canal, which had been completely filled up in both fragments for some distance from the break, is reëstablished.

Small pieces of comminuted bone may be imbedded in the callus and assist in increasing its bulk. These fragments, even if entirely denuded of periosteum, do not die, unless the fracture is infected with pyogenic germs or other septic organisms. Sometimes such pieces become necrotic and remain in the callus as foreign bodies, giving little trouble; though they are apt to cause prolonged irritation and interfere with union.

If there is much displacement union is effected between the nearest lateral surfaces of the bone, the open medullary cavity is covered in by new osseous structure, and the displaced ends of the fragments become round and smooth as in a stump left after an amputation.

Fractures of short and flat bones and of the ends of long bones are not accompanied by injury of marrow in a medullary canal. The process of union is, with the exceptions due to this fact, identical with that in the shaft of long bones. Unless there be much motion during the time of union, very little callus is found around the seat of fracture, and, therefore, the prominent oval mass felt in the form of fracture just de-

scribed is absent. This absence is probably due to the fact that the periosteum in these locations is less easily stripped up by the injury. Less laceration and less displacement therefore occur. Union is favored, moreover, by the broad surfaces of spongy and vascular bone which are in contact and by the less liability to motion from involuntary muscular spasms. Hence less callus is formed, for a large amount of callus usually means difficult repair because of great displacement or much motion.

When the line of fracture invades the articular surface of a bone the deposition of callus differs from that described in fractures not involving a joint. The bony surface covered with cartilage and bathed in synovial fluid does not usually furnish granulation tissue and callus as do the parts of the bone which are covered with periosteum and surrounded by muscles and fascias. Hence when union occurs it is by callus furnished by the envelope of the extra-articular portion of the bone and by the fracture surfaces themselves. There is no ensheathing callus on the articular surface to aid in repairing the edge of the fracture there.

The articular cartilage which is split by the same line of fracture does not unite; or if so the normal structure is replaced by cicatricial fibrous tissue only. As a result there is shown on the joint surface a groove in the cartilage or a line of uncovered bone to mark the position of the former fracture. Sometimes in injuries of this sort, as for example in fracture of the patella, where correct apposition has not been obtained, the bond of union is very imperfect, being mostly fibrous instead of osseous.

Open fractures, if aseptic, unite in a manner identical with that which has been described in closed fractures. If suppuration occurs, the repair is slower, because the warfare between the cells and the microörganisms is followed by death of much new tissue as well as destruction of the surrounding bone, muscle, and fascia. Violent inflammation of a mycotic kind is added, therefore, to the simple traumatic inflammation of aseptic fractures. Repair, therefore, is antagonized, and open fractures, unless they are early converted into closed fractures by primary healing of the soft parts next the bone, require a long time to unite. Superficial areas of bone or detached splinters may become necrotic and greatly retard healing of the soft parts and union of the main fragments. If much bone is lost by necrosis or by the shattering force causing fracture, bony union across the wide gap may be impossible, because the ossific influence is not great enough. Fibrous union then occurs.

Epiphyseal separations, or fractures, seem to unite as readily as true fractures. The union is said to be at once a bony one instead of by the normal epiphyseal cartilage as previously. The growth in length of the bone is retarded by this precocious union between the shaft and epiphysis. Agnew thinks that in some cases the epiphyseal cartilage at the other end of the bone acts in a compensatory manner by allowing an unusual lengthening there. Very little is known of the peculiarities of union in this form of injury.

Fractures of cartilages, such as the costal and laryngeal, which tend to ossify with advancing age, unite as bones by a material resembling callus.

Treatment.—The essential points in the treatment of fractures are the replacing of the displaced fragments as soon as possible, the prevention of recurrence of displacement, attention to the condition of the soft parts around the seat of fracture, and due consideration of the patient's general health. The surgeon's object is to obtain prompt union with as little deformity as possible. At times, unfortunately, more or less deformity is unavoidable, because of the situation and direction of the line of fracture.

Every effort should be made, however, to make this as slight as possible.

After receiving a fracture of the upper extremity the patient can usually walk to the place of treatment if the injured limb is supported by his other hand or a sling. If the lower extremity is the seat of suspected fracture, walking should be prohibited, and the patient carried by four men on a stretcher, settee, or wide board. It is recommended by some writers that these carriers should not keep step, because so doing has, it is said, a tendency to impart a painful swinging motion to the litter. Other writers advise them to step simultaneously. It matters little which precept is followed if the litter is held steadily and given no sudden jars; especially is this so if the patient lies immobile and does not try to move his body and limbs so as to neutralize the vibratory movements of the stretcher.

The patient must be carried in severe fractures of the upper limbs also if shock is great. A crude splint of board, twigs, straw, pasteboard, or any other material of sufficient rigidity to steady the fragments during transportation should be bound to the limb. This may be done outside the clothing. In fractures of the leg or thigh the opposite limb makes a good splint to which to bind temporarily the broken one. Hay, rags, or small pillows may be placed between the limbs before they are tied together.

The bed for the permanent treatment of a patient with a fracture of a leg or thigh should preferably be a narrow one, so that the attendants can conveniently reach each side of his body. A firm mattress that will not sag down under the buttocks is necessary. One made of hair and laid upon slats or woven wire is probably the best. The old-fashioned sacking bottom for supporting the mattress is undesirable. Patients accustomed to sleeping upon feather beds may be very uncomfortable unless they have softer mattresses than hair. In such cases a thin feather bed may be used if it is thoroughly supported by the framework beneath it. Good springs under a hair mattress are not objectionable if they do not permit the upper surface of the mattress to become uneven. There is no necessity for a specially made fracture-bed, if the bed-pan and urinal are carefully and intelligently placed when the contents of the rectum and bladder are to be voided. The sheet under the patient should be kept smooth; its edges may be tacked or tied to the sides of the bed. When a clean sheet is to be put under him it should first be folded or rolled up longitudinally for half its width. This doubled-up portion is to be carefully pushed under the right side of the patient while he is very slightly turned on his left side; then he is to be carefully turned on his back and slightly on his right side until a second person standing on the left side of the bed draws from under him the folded-up edge of the sheet. Very little movement of the patient is made when this method is adopted.

During long confinements to bed the sacrum, heels, and other points subjected to pressure should be washed frequently with equal parts of alcohol and water, and every precaution taken to avoid the occurrence of bedsores. Air mattresses may be demanded on this account in cases of fracture of the spinal column, where the accompanying paralysis greatly increases the tendency to bedsores.

Replacing the fragments in their normal relation, technically called reduction or "setting," should be attempted as soon as the patient has been conveyed to a convenient place. Early reduction—that is, reduction before the advent of inflammatory swelling—is nearly always demanded. It is less painful to the patient, and adjustment can thereby be more easily

and accurately accomplished than if the necessary manipulations are delayed. Moreover, the subsequent inflammation and chronic muscular spasms will probably be less severe if the sharp points of displaced bone are prevented by reduction from continually irritating and wounding the soft tissues. When the case has not been seen until severe inflammatory action has stiffened the muscles and greatly distended the fascias and integument by interstitial swelling, it may at times be proper to delay reduction until this condition has been relieved. Absolute rest of the part with the fragments in moderately good position should be adopted and accompanied, perhaps, by antiphlogistic local treatment, and sometimes even by incision through the constricting skin or fascia. After the lapse of a few days accurate reduction may be effected. The manipulations necessary for accurate adjustment, if made when the limb was stiff and so swollen, might cause rupture of vessels or nerves, or by increasing the internal pressure lead to gangrene. It may be judicious, perhaps, to delay also when there is evidence that the principal artery or nerve has been torn by the original injury, because the consequent gangrene might be attributed by a court and jury to the early manipulations made for reduction.

As a rule, however, fractures are to be reduced and dressed immediately; and only in exceptional instances should the surgeon be deterred from attempting accurate adjustment.

When subcutaneous hemorrhage or inflammatory swelling endangers the safety of the limb by arresting circulation, as shown by coldness and numbness of the fingers or toes, free incisions should be made through the tense integument to permit the fluids to drain away and thus relieve the pressure upon the vessels and nerves. Great stress is laid upon this measure, as threatening gangrene may often be averted by several cutaneous incisions of two, three, or four inches in length.

Reduction of displacement should be attempted even if the case is first seen several days or weeks after injury.* More force will be required under such circumstances; but of this more will be said under the discussion of Refracture of Deformed or Vicious Union of Fractures.

Reduction is sometimes readily effected by merely relaxing the muscles tending to cause displacement, whereupon the fragments fall into place. At other times some additional pressure and manipulation with the fingers are necessary before the more or less numerous pieces of bone are pressed into correct apposition. In still other cases an extending force must be applied to the limb on the distal side of the fracture, while counter-extension is exerted upon the other side of the seat of injury. By counter-extension I mean a resistance to the extending force so that the body will not be pulled in the direction of the force used to make traction on the overlapping fragments. Extension and counter-extension are to be made by grasping the limb above and below the fracture, and pulling with one hand while the other resists or pulls in the opposite direction. In dealing with a large, heavy limb it may be necessary for the counter-extension and sometimes the extension also to be made by an assistant. Such duties are also entrusted to assistants when the surgeon needs his fingers to mould the fragments into position. Extension-traction should be steady, continuous and moderate, and exerted in the axis of the limb. No greater force than can be obtained by the firm grasp and strength of the surgeon or assistants should be applied to the reduction of a recent fracture. Pulleys are never justifiable. What is required is a firm, steady pull of moderate force that will tire out the contracted muscles. Anæsthesia is often desirable, as it relaxes spasm and prevents pain. In

many cases ether has already been given to enable the surgeon to make a careful examination, therefore the reduction is at once effected and the fracture dressing applied before consciousness is regained. Extension overcomes shortening due to overlapping of fragments, but if there is lateral and rotary displacement, coaptation with the fingers and rotation of the limb should be added to the extension. These combined manipulations will usually correct the deformity. In impacted fractures and in open fractures with one fragment thrust through the integument, as through a button-hole, much difficulty may be found.

When a portion of bone into which a muscle is inserted is broken off it is to be put and held in position by traction exerted against the muscle. Fractures of the olecranon and patella illustrate this point.

Sometimes difficulty is experienced in properly and completely reducing the fragments. This may be due to impaction, to a fragment being entangled in or thrust through muscles or fascias, to one fragment being locked behind another and held there by muscular tension, or to actual crushing and powdering of portions of spongy bone. Inability to obtain a firm hold on one fragment may also be a cause of imperfect reduction. If muscles or fascias prevent reduction, subcutaneous section with a tenotome is justifiable to prevent permanent deformity from this cause.

An incision of skin and muscles is not infrequently required in open fractures before reduction can be obtained and also to permit thorough disinfection of the wound cavity and to make provision for free drainage. Whenever replacement is difficult, an endeavor should be made to replace the fragments along a course the exact reverse of that which was given by the vulnerating force. The portion of displaced bone should retrace the steps by which it reached its abnormal position.

After reduction has been obtained the limb should be compared with the sound side, and the test lines verified, to establish the correctness of the replacement. Swelling may make appearances deceptive. Great care in this respect is necessary in fractures near joints. Continuous extension by means of weights is often employed to overcome overlapping. It acts by gradually tiring out the displacing muscles, and thus effecting reduction. It is the usual method in fractures of the femur.

Closed fractures seldom require any lotions or other external medicinal applications. Lead-water and laudanum and similar remedies, applied to the skin, can avail little in relieving inflammation of broken bones and torn muscle. Immobility and freedom from muscular spasm are therapeutic agents of far more value than external lotions.

After reduction has been satisfactorily accomplished, displacements may recur through the action of gravity, muscular contraction, or restlessness of the patient. The surgeon must guard against such recurrence by applying some form of fracture dressing, which will retain the fragments in proper position. The best form of dressing will be that which corrects the tendency to displacement in the individual case, and, at the same time, steadies and immobilizes the limb. The special tendency to displacement varies in each case with the line and position of fracture, and should be recognized before the form of dressing is decided upon.

There are occasions in which no retention apparatus is needed, but these instances are rare. The confidence of the patient and greater safety against displacement are obtainable by adopting some mode of fracture dressing.

Fracture dressings may be grouped under three heads: (1) Those which give moderate continuous traction, or maintain extension which was applied

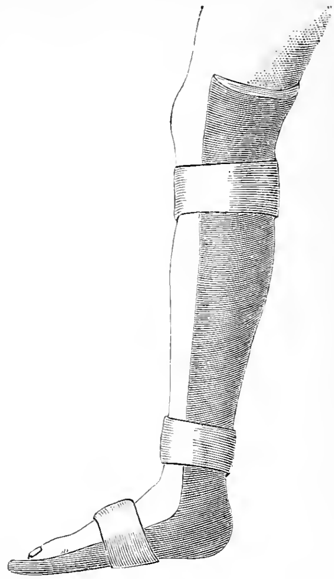
when the fracture was first adjusted; (2) those which, by virtue of their rigidity or fixedness, resist retraction; (3) those which, by virtue of their inflexibility, prevent angular or lateral displacement by giving lateral support to the fracture. These forms may be combined in the treatment of a given fracture. The simplest apparatus is the best. The articles employed in dressing fractures are: roller bandages; padding, such as cotton or oakum; adhesive plaster; splints of any rigid material, such as wood, felt, pasteboard; cotton fabrics stiffened with gypsum, silicate of sodium, or starch; fracture boxes; and weights for making continuous traction. As a rule, no roller bandage should be applied immediately to the limb under the splint, for the inelastic constriction thus made may lead to gangrene, if unexpected inflammatory swelling occur, and is, at any rate, of no service. Bandaging of the distal portion of the limb, beyond the splint, tends to prevent œdema there; which is often seen, because the fracture dressing, even when properly applied, interferes somewhat with venous return. It is usually preferable not to bandage even this portion of the limb.

The œdema, unless excessive or accompanied by discomfort, is of no importance. In dressing fractures of the shaft of bones, the nearest joint above and that below should, as a rule, be made immovable by the splint, because motion allowed at such articulations may cause displacement of the approximated fragments. Splints, if not moulded to the patient's person, should be padded with a thin layer of cotton-wadding, so as to make equable and elastic pressure, and thus accurately conform to the contour of the limb. A board slipped into a long bag, afterward smoothly stuffed with cotton, makes a good splint.

The splints after adjustment are to be held in place by spiral or reverse turns of a roller bandage, applied with sufficient firmness to maintain the apparatus in position, and thus make the limb rigid so that no motion can occur at the seat of fracture. The fingers or toes should usually be left uncovered that lividity, coolness, or œdema, due to improper constriction, may be noticed. The turns of the bandage can be kept from slipping by painting a broad line of mucilage or silicate of sodium down the outside of the completed dressing, or by applying a narrow strip of adhesive plaster down its exterior so as to hold the folds of the bandage. Another method is to stitch the bandage to the covering of the splint. Before applying the fracture apparatus, the skin should be washed with soap and water and shaved. In open fractures this is exceedingly important. Antiseptic lotions are to be used in these cases freely, to destroy any germs which may have gained access to the wound. Sublimate (1 : 500 or 1 : 1000) solution is probably the best; and can subsequently be washed out of the wound by a weaker solution. All recesses must be made aseptic, and drainage tubes used to drain all dangerous pockets. Counter-incisions are often demanded, and all devitalized parts should be trimmed away. In truth, the wound must be treated and dressed exactly as any other lacerated infected wound, and then have fracture appliances adjusted. Conformable splints of metal, felt or pasteboard, or moulded splints, such as will be described below, are far better than any form of carved wooden splint. A thin board may be made flexible transversely by cutting six or eight parallel longitudinal incisions in it, extending almost, but not entirely, through its thickness. A sheet of rubber adhesive-plaster may then be smoothly fastened over the uncut side, in order to strengthen the hinges made at the incisions when the board is bent.

Moulded splints are a most desirable form. They are at first sufficiently soft to be accurately fitted to the inequalities of the limb, but subsequently become hard. Felt, gutta-percha, and pasteboard may be thus moulded after being made soft by heat or moisture. Strips of gauze or any woven fabric with wide meshes can be converted into excellent splints by saturating them with a watery mixture of gypsum, the so-called plaster-of-Paris. Ten to twelve of these pasty strips, one over the other, are applied to the limb while it is held in proper position. They soon become rigid by the "setting" or hardening of the gypsum. Lateral or anterior and posterior splints of any shape may thus be made and held in position by roller bandages. If it is preferred, the limb may be encased in sheets or bandages of gauze saturated with gypsum. This method is that used in making the so-called immovable dressings, which are often very valuable after the primary inflammation of injury has subsided. These hardened encasements, if made with silicate of sodium, glue, or any material with some elasticity may be split open on one side, so that they can be sprung open, somewhat as a book, and thus become movable splints. They may be furnished with eyelets, and thus laced like a shoe when reapplied.

Fig. 148.



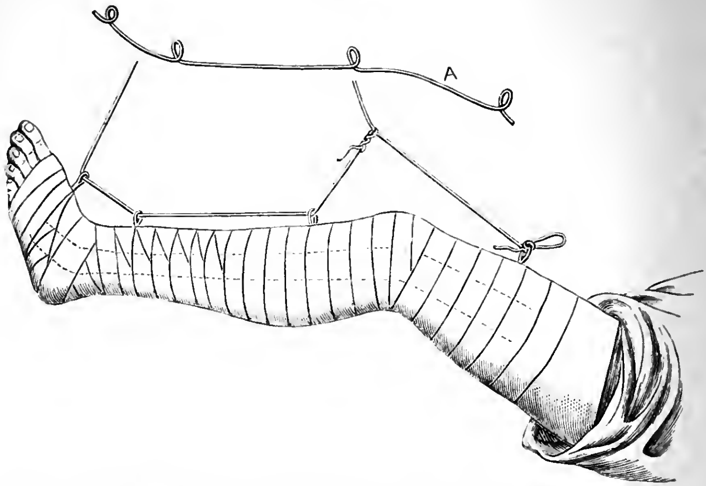
Posterior gypsum splint for fracture of the leg. (Stimson.)

The gypsum powder for this purpose must be kept dry, for, if it absorbs moisture, it will not "set." It may be mixed with enough water to make a paste of the consistence of cream, which is rubbed into the gauze at the time of dressing the fracture, or the dry powder may first be rubbed into the meshes of the gauze and the gauze strips or bandages dipped into water as needed. If gypsum gauze is not used at once, it should be preserved in a dry place. The setting can be retarded by the addition of a little dissolved glue, of borax, or cream of tartar to the water, and hastened by using hot water or adding salt. A little skill in cutting out V-shaped pieces of the sheets of gauze, and in overlapping the edges thus made when corners are to be turned, will enable the surgeon to make moulded splints to suit fractures in all regions. Such splints may be varnished to prevent absorption of fluids, and strengthened by incorporating strips of zinc between the layers. In open fractures which have become infected, and are therefore suppurating, openings may be made in the splints, so that the wound may be dressed without displacing the fracture apparatus. Strips of metal to strengthen the dressings, or wire rings for suspension, may be incorporated within the layers.

Reduction of overlapping fragments is sometimes best accomplished by continuous traction by weights. The displacing muscles are thus tired out, and their tendency to either tonic or clonic spasm overcome. The cord carrying the weight passes over a pulley and is attached to the limb

by strips of adhesive plaster. The tendency to lateral displacement is then obviated by coaptation splints at the seat of fracture. This method

FIG 149.

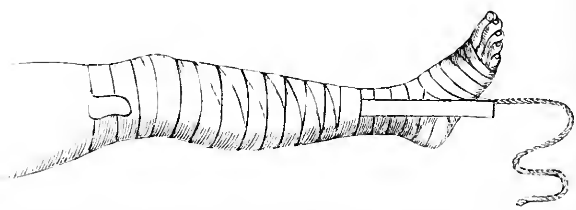


Anterior and posterior gypsum splints with wire rings applied for suspension in fracture of leg. (STIMSON.)

is most employed in fractures of the femur, but is at times useful elsewhere.

It is a safe plan always to remove the splints within twenty-four hours

FIG. 150.



Adhesive plaster and foot-board applied for continuous extension.

FIG. 151.

Encasement in immovable gypsum dressing for fracture of leg. (STIMSON.)

after the first dressing. Bad fractures should be *visited* within a few hours after the original dressing, lest unusual swelling may have occurred

and rendered the dressings too tight. If, after the second dressing, no undesirable symptom has occurred and the limb feels comfortable, removal of the apparatus is not called for oftener than two or three times a week. Daily inspection of the patient should, however, be enforced for ten days or so, even if no change is made in the dressing. When the surgeon takes off the splints the limb should be held by an assistant, who should firmly grasp it above and below the fracture and allow no motion or displacement. After the skin has been washed with soap and water, or with alcohol, the limb should be dried and carefully examined for abrasions or bedsores, due to pressure, and for any renewal of deformity. It should ever be recollected that absence of discomfort is not a token of absence of deformity. Dressings which allow the seat of fracture to be always under observation are therefore desirable, though it is not always convenient to adopt them.

If no untoward symptom occurs within two weeks, change of dressing once a week is sufficiently often; but the possibility of angular displacement, even so late as four or five weeks, must be remembered. Loosening of bandages or sinking in the bed may cause lateral or rotary movement at the seat of fracture.

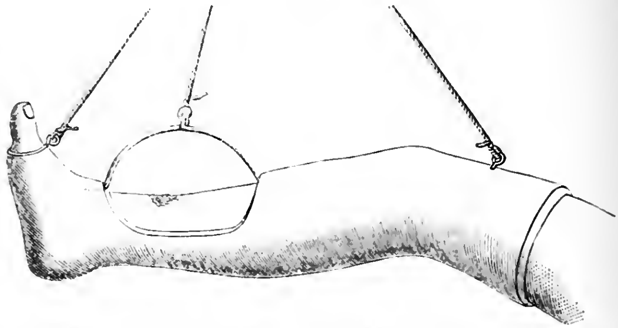
Retention apparatus may, as a rule, be discarded in uncomplicated fractures of the upper extremity at the end of from four to six weeks, and of the lower extremity at from six to eight weeks. The bones should be subjected to no muscular strain for two or three weeks subsequently. During this time, and often longer, slings or crutches are needed. The union becomes firm in children sooner than in adults.

Persistent pressure of the splint or bed upon any bony protuberance is liable to cause a localized chronic sloughing of the skin and subcutaneous cellular tissue, technically called a bedsore. This result must be avoided by careful padding, frequent change of the points of pressure, and bathing the cutaneous surface with water or alcohol. A patient can often change his posture in bed without detriment if a rope, attached to the ceiling over his head, is allowed to hang within reach. Bedsores often occur without any sensation of pain or burning. The surgeon must look for them, and not be satisfied with a reply that there is no pain. If a dark spot is seen on the heel, elbow, sacrum, or other prominence, a bedsore already exists. The slough must be detached before the sore will get well. Hence, moist antiseptic dressings should be applied for a time. The ulcer remaining after the detachment of the slough is to be treated by antiseptic dressings to prevent suppuration, and possibly by applications, such as chloral in solution or ointment (gr. x to ℈j), nitrate of silver and iodoform.

The inflammatory symptoms at the seat of injury in closed fractures usually need no treatment. Correct apposition and prevention of motion are the essential features. The blebs that sometimes form on the surface may be let alone, unless they are large; then they may be punctured with a needle to allow the bloody or straw-colored serum to escape. Wrapping the limb in cloths saturated with lead-water and laudanum, before applying the splints, is improper. Such measures do no good, and the dressings, acting as poultices, may cause blebs to arise which otherwise would not have appeared. Muscular spasm about fractures is best combated by morphia given by the mouth or hypodermically. Retention of urine requiring catheterization is not infrequent after fracture of the thigh. Abscesses, traumatic fever, delirium, tetanus, erysipelas, and other complications, must be treated on general principles. Gangrene due to arterial rupture or thrombosis simultaneous with the fracture occurs at

times; it may also follow constrictive pressure from excessive inflammatory swelling beneath the skin and fascia. When the last condition is feared, free cutaneous and fascial incisions, as previously described, will relieve the tension by allowing gaping, and thus often avert the calamity. Injudicious bandaging has often caused gangrene. In gangrene from any of these causes it is usually well to wait for the line of demarcation before amputating. If, however, the destructive process is rapidly spreading, immediate amputation at a high point may be judicious.

FIG. 152.



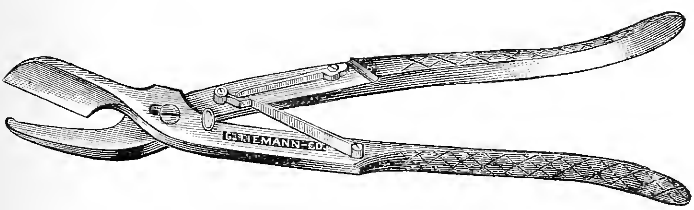
Suspended and fenestrated gypsum encasement for fracture of leg.

Immovable or fixed dressings, which, however, allow no inspection of the fractures, are often used when the fracture has been reduced and there is no fear of swelling. They should not be employed in the early days of a fracture. It is much safer to wait until all inflammatory action has subsided and there is some solidity given to the broken bone by the beginnings of repair. The end of the second or third week is early enough for their employment. Encasements are made from bandages or cloths saturated with gypsum, silicate of sodium, or glue, as has been mentioned above in describing moulded splints. Before the immovable apparatus is applied the limb should be smoothly enveloped in soft flannel or a layer of cotton wadding. Then the roller bandage soaked in gypsum should be applied circularly to the limb, without being drawn at all tightly. Silicate of sodium solution may be used instead of gypsum. It dries more slowly than gypsum, but makes a more elastic encasement, which, when split, can rather more readily be pulled apart, so that the limb may be lifted out and examined. Such a split encasement then becomes a movable splint. I usually so employ the so-called fixed dressings. As the limb shrinks because of absorption of inflammatory deposits, the splint will become too loose and allow displacement of the fracture. It should then be removed and replaced by a new one, unless it is elastic enough to be opened, padded, and reapplied. Eyelets and laces may be inserted for the purpose of regulating the degree of constriction. The seat of fracture or wound may be left open to inspection by an opening in the encasement. Powerful shears are the best instruments for dividing fixed dressings which are to be removed, but a saw or knife may answer. Gypsum encasements may be softened before using the knife by applying muriatic acid along the line of proposed division.

Fractures running into joints are apt to be followed by ankylosis be-

cause of the arthritis that arises secondarily to the bone injury. The joints adjacent to a fracture are usually kept immovable by the splints in order to prevent motion at the point of fracture. Hence, when the apparatus is finally removed these joints often show considerable stiffness, due to disuse for several weeks and to the inflammatory exudate among the muscles and fascias. Passive motion of these joints by the surgeon at the time of rearranging splints during the treatment of the broken bone is often insisted upon. Such motion, unless very slight, may displace the fragments. Hence, it has long been a mooted question whether the surgeon should commence these manipulations early or late. In any case where there is probability of passive motion displacing the fragments it should not be commenced until firm union has taken place. Four weeks is early enough in all these doubtful cases. If arthritis has occurred as a complication, absolute rest is indicated and passive motion will do harm. If no arthritis has occurred, the stiffness due to disuse can readily be overcome by passive motion at a later date when there is no risk of interfering with bony union. Then the patient can supplement the passive motion employed by the surgeon by rubbing and moving the limb with his own hands or pulling against a resisting force. Passive motion which is followed by pain and tenderness of the joint is usually deleterious, for it means that arthritis exists.

FIG. 153.



Shears for cutting through gypsum dressing.

When a fracture is complicated by dislocation of a neighboring joint, the surgeon should endeavor to reduce the dislocation at once. The necessary leverage may often be obtained by applying such temporary splints as will steady the broken bone. Afterward the same or other fracture dressings may be utilized for the treatment of the fracture.

Treatment of Open Fractures.

The treatment of open fractures—that is, of fractures complicated by a wound leading to the seat of fracture which communicates with the air—varies with the character of the injury. The indications are to replace and retain the fragments in apposition and obtain rapid healing of the wound. The last indication is usually, though not always, possible of fulfilment if the wound is promptly made aseptic and kept so. Hence, the surgeon, after reduction of the fracture, should cleanse the wound with antiseptic washes, such as corrosive sublimate solution (1 : 500 or 1000), and treat it so as to avoid virulent consecutive inflammation due to infection. When a portion of the bone protrudes through the skin, manipulation, relaxation of muscles, enlargement of the wound, tenotomy, and resection of the ends of the fragments should be practised to accomplish replacement. When the bones constantly

slip out of apposition resort should be had to wiring them together by means of holes drilled obliquely through the extremities, or by driving sterilized bone pins or steel nails into the osseous tissue and twisting the wire around them. Loose splinters and all foreign bodies should be picked out of the wound. Portions of bone still maintaining periosteal attachments should be permitted to remain. Fractures complicated with wounds are almost certain to suppurate unless they are managed with rigid antisepsis, because they have been infected before they are seen by the surgeon. They should be thoroughly washed out by antiseptic lotions after the surrounding parts have been scrubbed with soap and water under anæsthesia, and only closed after provision for free drainage has been made by means of counter-incisions and drainage-tubes. All dirt and foreign material must be removed. The method of rendering such injuries aseptic has been described under the Treatment of Wounds; for an open fracture is a lacerated wound of soft parts and bone. When washing out an open or compound fracture with the antiseptic solution, provision should be made for the outflow of the blood-stained fluid, so as not to leave poisonous fluid in the cavity on the one hand or to fail to get rid of septic bacteria on the other. Counter-openings or enlargement of the original wound may be demanded for this object. Intramuscular or subcutaneous lacerations often extend up and down the limb a long distance from the seat of fracture. These may require long incisions in order that efficient disinfection may be accomplished. After thorough irrigation, the wound is to be dressed on general principles with a voluminous antiseptic gauze dressing. If the attempt to get primary union has failed, the first indication of suppuration is to be followed by immediate opening, sterilization, and drainage of the wound. The surgeon's nails, hands, and instruments must be sterilized before undertaking these manipulations. Failure to get primary union of the soft parts is evidence that the wound was not made sterile.

Ordinary fracture apparatus, to maintain proper position of the fragments, must next be applied outside of the gauze dressings.

When a simple fracture shows signs of becoming open because of cutaneous sloughing, an effort should be made to prevent as long as possible the separation of the eschar by keeping it aseptic.

Some open fractures demand immediate amputation, because the injury is so severe that the sloughing sure to follow will probably prove fatal. If, after an attempt to save the limb, unexpectedly severe symptoms occurred, it was formerly considered to be usually better to delay amputation until suppuration and sloughing had been fully established. In other words, intermediary amputations in such injuries were apt to be disastrous. Immediate amputations—that is, those done as soon as reaction from shock had occurred, and those done after the lapse of about ten days, when suppuration was fully established—were thought more likely to be followed by recovery. This is no longer a rule, as antiseptic methods have altered the clinical history of all wounds, and will reduce the amount of suppuration and the degree of septic poisoning in those cases where the impossibility of obtaining a sterile wound has prevented primary union.

Antiseptic methods have enabled surgeons to save many limbs subjected to open fractures, that under previous methods of treatment would have required immediate amputation to save life. Almost any open fracture in which the tissues are not absolutely devitalized can be successfully treated if made perfectly sterile and kept so. I have been astonished at

my success in these cases. Amputation is usually required in railway and other injuries which cause crushing of the bones and pulpefaction of the soft parts. Similar treatment is often demanded when the main artery has been opened by the injury. In the upper extremity conservative surgery is attended with less risk to life than in the lower limb. Moreover, the fact that artificial legs are very serviceable, while artificial hands and arms are practically useless, argues something in favor of not taking too much risk by trying to preserve a doubtful leg. It must be remembered, however, that amputations high up in the thigh for any cause have a somewhat high death-rate. Open fractures involving large joints may often be treated by primary or secondary excision of the joint instead of amputation. Gunshot fractures involving joints are an exceedingly serious form of open fractures. If in open fractures running into joints the limb is to be saved, antiseptic cleansing, free drainage, perhaps by many counter-openings, antiseptic irrigation, and in extensive fracturing, excision must be the resorts of the surgeon. Excision may sometimes be delayed and performed as a secondary operation when it can be better determined how much bone must be sacrificed. Rigid and thorough provision for escape of all wound fluids must be insisted upon in all these injuries. Drainage is an essential factor in open fractures.

Ununited Fracture or Pseudarthrosis.

Pathology.—It is occasionally found that some degree of mobility and pain on motion persists after the lapse of what ordinarily would be sufficient time to cause consolidation of a given fracture. Such instances are denominated cases of delayed union. If successive weeks or months pass without union occurring at the seat of fracture, the condition is ununited fracture, false joint, or pseudarthrosis. Delayed union is usually the result of deteriorated general health, while false joint in almost all instances depends upon some local condition pertaining to the fragments themselves. Many cases of delayed union finally terminate in complete consolidation without any special treatment beyond building up the patient's health. False joints, however, whether sequences of delayed union or cases showing from the beginning no tendency to union, persist, and require either the adaptation of apparatus to supply the normal rigidity of the limb or active and judicious surgical treatment. Efficient apparatus is more easily obtained for non-union in the upper than in the lower limb, because of the weight-sustaining function of the latter.

It is not customary to apply the term ununited fracture to the fibrous union that frequently occurs when short, spongy bones and the spongy ends of long bones are broken, or when prominences for muscular attachment are torn loose. These fractures would probably unite by ossific deposition, as other fractures do, if correct apposition was obtained and maintained. They actually, therefore, are cases of unuited fracture, though not called so. The bond of union holding the fragments together after healed fracture occasionally undergoes softening and absorption during the progress of phlegmonous inflammation of the limb, scurvy, or other grave disorder. It is manifestly improper to apply the term ununited fracture to this condition when it occurs subsequent to complete union of the osseous lesion. Atrophy of the bone itself sometimes occurs after fracture.

Ununited fracture is a comparatively rare condition. The cases may

be divided into three classes: 1, those in which there is no bond whatever; 2, those in which there is more or less successful attempt at union by means of bands of fibrous tissue and nodules of bone; 3, those in which a crude joint is formed as exhibited by cartilaginous material on the apposing surfaces of bone, synovial fluid, and a capsule. The first and third varieties are very unusual. The second form is that usually found when ununited fractures are dissected. The length and disposition of the fibrous bands vary in accordance with the relation of the fragments. There may be a mass of callus partially ossified and little fibrous tissue; or little callus with bands of fibrous tissue uniting the fragments somewhat like interosseous ligaments. This kind of non-union gives a flail-like limb if the bands of fibrous tissue are long. It is more movable than the form described as having a joint-like structure.

Causes.—Syphilis, pregnancy, advanced age, acute diseases, and other sources of physical deterioration and malnutrition have been described as causes of ununited fracture. They apparently, however, have little influence in giving rise to non-union, though delayed union may perhaps be due to them. Non-union is nearly always the result of a local cause, and this local cause is usually mechanical. The most frequent agencies are: (1) unfavorable relation of parts, such as great separation of the fractured surfaces by reason of displacement, actual loss of substance, or necrosis; (2) defective treatment, by which immobility of the fragments is not secured; (3) portions of fascia or muscle, and bullets or other foreign bodies lying between the fragments; malignant and other growths in the same location. Destruction of the nerves coming from the trophic centres in the lower part of the spinal cord, or of the centres themselves, has been with apparent reason assigned as a cause of ununited fracture or pseudarthrosis. It is also stated that softening or absorption of callus may follow the too early use of a broken limb. This occurrence is doubtless the result of motion at the seat of a partially ossified callus union and comes under the head of defective treatment mentioned above.

Diagnosis.—The diagnosis of ununited fracture is made by preternatural, and, in most cases, painless mobility existing long after the time for consolidation has passed. Near a joint such mobility may simulate the normal articular movement; or, a joint with relaxed ligaments may simulate ununited fracture. The character of the defective union is often obscure. If it is simply delayed, an elastic mass of callus, which is the seat of pain on strong passive motion, will probably be discerned by palpation. If a crude joint has been developed, no callus and no pain will be found; nor will the flail-like mobility of long fibrous attachment exist. Careful palpation and puncture with long needles will at times determine the position and shape of the fragments.

Treatment.—The treatment of delayed union consists in friction of the limb, change of air, nourishing diet, and the administration of alkaline phosphates and carbonates, and of tonics. A few additional weeks under good hygienic circumstances is all that is usually demanded.

Ununited fractures, whether fibrous or articular, demand much more active measures, of which the milder forms, however, should first be employed. Rectification of any displacement that seems to interfere with union should be accomplished, after which the immovable gypsum dressing should be applied and worn for a month. If any increase of consolidation is observed this dressing should be continued for several months, during which time the patient may go about on crutches if it is the lower limb which is the seat of injury. If the part becomes painful

from excoriation, the encasement may be split and laced or removed, and a new one applied. The latter method is probably the better. During this period the hygienic measures noted above for delayed union should be adopted. The application of the descending constant current has been recommended, but is probably valueless.

Failure to accomplish anything by these plans necessitates the adoption of operative measures, unless more support by apparatus to give rigidity is acceptable to the patient and surgeon.

The operative plans aim either at setting up inflammatory action at the seat of non-union, and thus stimulating functional activity; or, at converting the old ununited fracture into a recent one with freshly-sawed surfaces in apposition. Violent bending and rotation, such as will tear apart the fibrous connections and cause the ends of the fragments to be rubbed upon each other, will often be followed by consolidation. These manipulations may be repeated daily until tenderness and swelling follow. Upon the appearance of these symptoms the limb should be immobilized in splints and treated as a recent fracture. As a rule, the fibrous union can at one sitting be torn up and the ends rubbed with sufficient degree of force to cause the advent of tenderness on the following day. The bones may be bent at right angles and extensively rotated and extended without endangering the safety of vessels or other tissues. To be of service the manipulation must be thoroughly done; usually under influence of an anæsthetic. When the operation does not succeed in causing deposition of callus and consequent union, subcutaneous drilling of the fragments may be tried. A bone drill is introduced through a small puncture in the skin and the ends of the fragments perforated in various directions. Afterward retention apparatus is applied. Ostitis is the result of this treatment, and may be followed by union. A similar ostitis has been induced by driving an ivory peg through or into each fragment, in which a hole has been previously made by means of a drill. The fibrous bands should previously be ruptured by passive motion. The pegs, which do not pin the bones together, are withdrawn in a few days when pain is felt in the osseous tissue. A better plan, when practicable, is to bore holes into the fragments and pin them together by means of metal screws or pegs of ivory or bone. These may be cut or broken off close to the surface of the bone, and the tissues allowed to heal over them. Thus the fragments are held in position while productive ostitis furnishes callus to join them firmly and permanently. The ivory and bone pegs will become absorbed, the steel screws encysted. If the surgeon prefers, the screws or pegs may be allowed to project from the wounds of entrance and be withdrawn in two or three weeks, when consolidation is partly accomplished. This method is more apt to permit purulent infection and cause suppuration than the former, but may in some instances be preferable. The bone pegs are readily made from bone knitting needles.

The most radical operation for ununited fracture is resection of the wounded ends of bone. It makes an open fracture, but it is often the only method that will lead to a cure. This is especially so in cases where the non-union has caused the formation of a joint-like structure, and where the failure of union is due to dead bone or portions of muscle between the ends of the fragments. The danger formerly belonging to this procedure is obviated by the methods of antiseptic surgery. Suppuration will seldom occur. A longitudinal incision is made, the ends of bone turned out and sawed off after saving as much as possible of the periosteum, the limb put up in splints, and the wound treated antiseptically, as

in open fractures. The chisel, bone cutters, or saw may be used to remove the pieces of bone. Sometimes the ends may with advantage be fastened together by wire, sterilized bone pegs or screws, as in accidental open fracture. These substances may be cut off short and left in the wound, or be taken out in about three weeks. As little as possible of the bone should be sacrificed, only enough to give a broad, fresh surface of contact. Sometimes shoulders are cut so that the fragments may be interlocked or mortised together. Transplantation into the gap of small portions of bone from the human subject or from lower animals has been practised with apparent success. It may happen that the excision of the ends of the fragments with pegging or wiring them together will, if done antiseptically, produce so little irritation that there is not enough productive inflammation to cause union. When this is feared, it is best to leave the wound in the soft parts open and plug it with antiseptic gauze, so that more irritation will be induced and union occur only by second intention. The outside dressing must be carefully applied, so as to prevent putrefactive or purulent infection. Death frequently occurred formerly after operations for ununited fracture from suppuration and sepsis.

Amputation is not to be considered in cases of ununited fracture, except under exceptional circumstances, and when resection or one of the other operations has been followed by gangrene or diffuse suppuration.

Deformed or Vicious Union of Fractures.

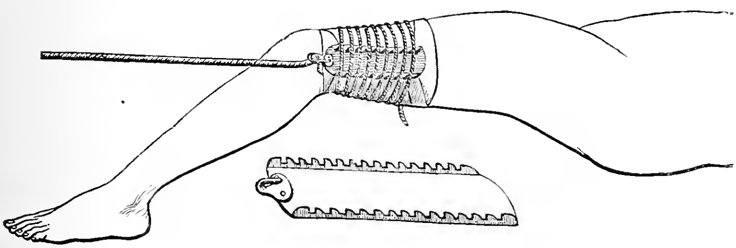
Pathology.—Absence of proper treatment in cases of fracture often gives rise to deformed union, because callus will be furnished and consolidation of the bony structures usually occurs, even when the fragments have not been placed in correct apposition. Great disability may thus result, especially in the lower limb. Angular deformity or overlapping will cause shortening; the presence of an abnormal projection near a joint may interfere with flexion and other articular movements. Change in the long axis of the fragments and rotation may cause the weight of the body to throw unusual strain on the lateral ligaments of the knee and ankle, and produce secondary deformity in these situations. Vicious union may also give trouble by causing painful pressure upon nerves, or by inducing ulceration of the skin over projecting portions of bone. In the forearm pronation and supination may be obstructed by bridges or masses of callus attached to the radius and ulna. Deformed union sometimes allows muscles and tendons to become entangled in the callus, and thus, if not remedied at an early day, gives rise to permanent impairment of muscular action.

There are two methods of treatment: subcutaneous refracture, and division of the deformed union. The former is less dangerous than the latter, and, in fact, is practically devoid of danger, because it merely creates a closed fracture which unites promptly, and there is naturally much less disturbance of the soft parts than in similar fractures of accidental origin. Hence little reaction follows. Experience shows that refracture or rupture can be done as late as six and twelve months after consolidation has occurred, and that with proper precautions the bone need never be broken at other than the seat of original injury. Gradual bending and attempts to soften the callus by applications or medication are a useless waste of time.

Angular deformity is the variety that most frequently demands cor-

rection. Fortunately it is also the most amenable to improvement. Refracture of malunion a few weeks old can usually be accomplished by seizing the limb firmly with the hands and forcibly bending the bone at the seat of the old fracture. The bending is generally made in such a way as to attempt at once straightening the bone. Sometimes it is better to bend first in the direction of the flexion, as is done in breaking up an ankylosed knee. It may be necessary to place a fulcrum, such as the operator's knee or a block of wood, against the convex surface of the angular deformity. Another method is to have the limb projecting over the edge of a table and steadied upon the table by an assistant, while the operator takes the distal end and suddenly throws his weight upon it. A sudden force is much more effectual than gradual bending, which will be found unavailable in all but recent cases. It is often well to bind a straight splint to the limb below the seat of proposed refracture and another above it, but neither of them should overlap the mass of callus. These splints prevent motion and strain of the joints, give the operator more leverage, and avoid the remote possibility of fracturing at any other than the desired point. Strong extension and counter-extension by means of pulleys may be applied at the time the cross-breaking strain is exerted. The attachment of the pulley-rope can be satisfactorily made by the notched extension plate of Dr. R. J. Levis. When shortening is great it may be well to continue anæsthesia and excessive extension for an hour or so after refracture, to gain as much length as possible before dressing. Some form of osteoclast, such as Taylor's or Rizzioli's, may be employed in very firm consolidation.[1]

Fig. 154.



Levis's notched extension plate.

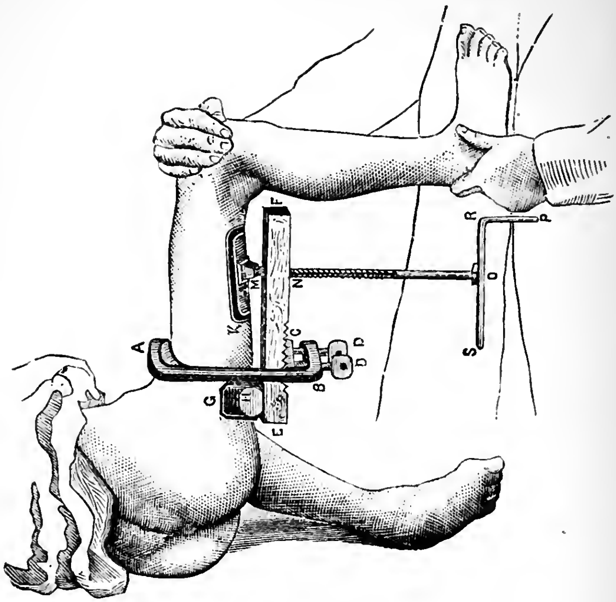
When the deformity depends upon lateral application of the two bony cylinders rupture must be attempted by flexion across the bond of union, combined with rotation in the axis of the limb, and strong extension and counter-extension. These cases are not as amenable to treatment as angular malunion.

Division of the deformed union should only be employed when correction by refracture is impossible, because it creates an open fracture, and may lead to suppurative dangers from neglect of antiseptic precautions. An incision in the soft parts is made, and through this a small chisel or saw is introduced. The callus is then divided, the deformity corrected, and dressings applied as in open fractures. If simple division of the bony tissue will not permit adjustment, or if the tissues of the concavity are very tense, a wedge-shaped piece with its base at the convex surface may be excised.

[1] See Edinburgh Medical Journal, July and August, 1878.

Projecting spurs of bone, acting deleteriously because of pressure or their position near joints, may be removed with the saw or cutting forceps, very much as an exostosis, and usually with as little risk. The operative

Fig. 155.



Taylor's osteoclast.

treatment of malunion in the forearm interfering with pronation and supination is surrounded with a good deal of difficulty. In some cases division or excision of callus is justifiable.

Special Fractures.

Fractures of the Vertebræ.

Fractures of the vertebral column derive their chief importance from the damage to spinal cord and nerve trunks, which so often accompanies them. The spine requires solidity and flexibility in order to give support and movement to the head, trunk, and limbs; but its protective function, as regards the spinal cord, is even more essential to life and health. As in cranial, so in spinal fractures, the surgeon is more anxious concerning the integrity of the contained nerve elements than he is about the osseous lesion.

The vertebral column quite frequently sustains fracture from an indirect violence which tends to produce over-extension or over-flexion of its normal curvatures. For example, a man falling from a height on his head or buttocks, or being crushed under a weight falling from above upon his head or shoulders sustains a fracture of the spine, because the limit of flexion or extension has been exceeded and the bony segments are crushed or lacerated by the force. The fracture in such instances usually

occurs where a movable portion of the column joins a more rigid portion, because here the sudden check to movement occurs. Hence, clinical experience shows spinal fractures from this form of injury to be more frequent near the dorso-lumbar junction and in the vicinity of the fifth and sixth cervical vertebræ.

Pathology.—The bodies of the vertebræ seem to suffer from fracturing forces oftener in the lower than the upper region; while the arches are more frequently broken in the neck than elsewhere. Fracture of the spinous process occurs most often in the dorsal region. The lines of fracture and the number of vertebræ involved depend upon the direction and degree of the force. Dislocation often accompanies the fracture. Indeed, the two conditions are frequently indistinguishable except by post-mortem examination.

Contusion, compression, and laceration of the spinal cord may be caused by displacement of the fragments. It requires considerable displacement to pinch the cord, for the canal is much wider than the spinal cord and its membranes. As the cord ends at the level of the first or second lumbar vertebra, fracture below this point can only compress the leash of nerve roots and branches called the cauda equina or horse-tail. Hemorrhage from the venous plexuses between the bony wall and the dura mater may be a result of the fracture. Such hemorrhage and inflammatory products may exert pressure on the nervous structures. Extravasations of blood into the cellular tissue in front of and around the spinal column often occur, and after a time may appear upon the surface of the face, chin, neck, and other regions.

Symptoms.—There is often in vertebral fractures no noticeable deformity, preternatural mobility, or crepitation. The diagnosis must then depend upon the rational symptoms, which are, for the most part, referable to lesion, either primary or secondary, of the spinal marrow. Depression may sometimes be discovered over a fractured spinous process or vertebral arch, or an angular prominence may be perceptible posteriorly after crushing fractures of one or more vertebral bodies. Unusual mobility may be observed at times, especially in fractures of the cervical region, and occasionally movable regions may become more or less immobile, because of spasmodic contraction of the muscles about the fracture, or because of interlocking of the fragments. Crepitation may be present, absent, or discernible only by the patient. The manner in which the spinal column is bound together with ligaments and surrounded with muscles often prevents the discovery of these symptoms of fracture, even when extensive fracturing exists. Localized pain, increased by manipulation or motion, is usual in fracture of the vertebræ, but is not diagnostic of the character of the injury.

In spinal fractures intelligence is unimpaired, except, perhaps, during the stage of shock. Paralysis of the parts supplied by the nerve branches, leaving the cord at or below the seat of injury, is a common symptom. In locating a fracture by this symptom it must be recollected that the nerve roots and branches run obliquely downward within the vertebral canal, and do not escape at the inter-vertebral openings corresponding to their points of origin from the medulla. For example, paralysis of the legs and trunk, extending as high as the distribution of the first lumbar nerve, would suggest that the fracture was located about the eleventh or twelfth dorsal vertebra. The paralysis is usually both motor and sensory, and is partial or complete, according to the character of lesion in the cord. When complete, the area of cutaneous insensibility is sharply defined.

Pricking the surface with the point of a pin is an easy method of determining the paralyzed area, and of estimating its increase as the cord becomes involved in inflammatory processes extending upward. The lower limbs alone will be motionless, if the fracture is below the origin of the brachial plexus. Otherwise the arms will be paralyzed also. There is usually no reflex contraction upon pricking or pinching the paralyzed limbs, and electrical contractility is soon lost. If the paralysis is incomplete, hot and cold sensations may be distinguished. Sometimes cutaneous hyperæsthesia exists. Darting pains may be felt in the limbs when the partially paralyzed extremities are moved, though spinal pressure elicits no such symptom. The occurrence of such pains is under some circumstances a sign of returning innervation, and, therefore, a symptom of beginning improvement. Tonic or clonic spasms of the muscles are occasionally observed, and may be excited by manipulation, drafts of cold air, and similar irritants. The paralysis may not be present immediately after injury, but may supervene upon movement causing displacement, or arise from an intraspinal hemorrhage or the development of inflammation of the cord or its membranes. The superficial branches of nerves coming from the medulla above the lesion may supply the integument for a considerable distance below the injury, and thus deceive the surgeon as to the location of the fracture.

As a result of the paralysis retention of urine occurs, to be followed after a time by overflow and incontinence. Alkaline fermentation of the urine within the bladder, and cystitis, soon supervene. Constipation, followed by incontinence of feces, is another paralytic phenomenon. Tympanitic distention of the abdomen also takes place. In fracture of the upper regions the respiratory distress due to paralysis of the abdominal and other muscles of respiration is increased by this tympanitic distention, which prevents full descent of the diaphragm. Bedsores appear, often within two or three days, because the insensitive and motionless limbs do not change the points of pressure. The probable occurrence of bedsores is increased by the difficulty of keeping the sheets free from urine and feces, which are evacuated unconsciously.

Persistent vomiting and marked elevation of temperature of the palsied region have been observed in fractures of the upper part of the spine.

Priapism, more or less marked, is a common accompaniment of spinal fracture. It seems to diminish in frequency as the injury occurs lower in the vertebral column. Seminal emissions sometimes take place. Introduction of the catheter to relieve the distended bladder, though not felt by the patient, may increase the erection or cause a partial erection if none was previously present. I am not cognizant of erection of the clitoris having been noted in females suffering from fracture of the spine. Analogy suggests its probable occurrence.

A careful clinical study of the symptoms of spinal injuries will lead to a more correct localization of the seat of fracture than is possible by a cursory survey of the case. Spinal localization, as cerebral localization, needs more consideration at the hands of surgeons. This matter has been referred to in the chapter on Intraspinal Inflammation. Brain lesions may coexist with spinal fractures and complicate the problem.

Fractures of the atlas and axis are very dangerous because they are apt to involve the integrity of the medulla oblongata, with its numerous nerve centres, and are above the roots of the phrenic nerves which, going to the diaphragm, are the chief respiratory nerves. If cord injury occurs and death is not immediate, the paralysis will almost certainly involve

the trunk, arms, and legs. Fractures below the axis and not lower than the second dorsal vertebra are of unfavorable prognosis, because this includes the roots of the origin of the phrenic nerves and brachial plexuses. The phrenic nerves emerge between the third and fourth cervical vertebræ, coming from the fourth cervical pair alone or having accessory roots from the third and fifth cervical nerves. The brachial plexuses are derived from the fifth, sixth, seventh, and eighth cervical and first dorsal nerves. Hence injury at, or no higher than, the fourth cervical vertebra will involve the innervation of the arms, but will allow the functions of the phrenic nerves to go on unless intraspinal hemorrhage or inflammation extends above the level of the fracture. Lesion of the cord above the fourth, sufficient to induce paralysis, will probably involve the phrenics and cause death promptly by respiratory failure due to paralysis of the diaphragm. When the other muscles of respiration, but not the diaphragm, are paralyzed, the character of breathing is peculiar. Inspiration occurs from diaphragmatic action alone and expiration from the abdominal walls and viscera pressing the diaphragm up. Expiration is consequently passive and feeble; hence the patient is unable to talk, cough, or sneeze forcibly and the lungs become clogged with mucus. Change of posture, by changing the pressure, may alter the complexion of symptoms.

The character of the lesion in the cord determines the extent and nature of the symptoms. Palsy may affect one or both arms or only certain groups of muscles in the upper extremities. So the phrenic nerves may be slightly involved and slow the movement of the diaphragm instead of stopping it entirely and causing immediate death. Slow pulse, some cyanosis, delirium, and coma may be observed in the clinical history of fracture of the cervical vertebræ. Irregularity in the posterior wall of the pharynx may be observed if the cervical vertebral bodies are fractured or displaced. The paralysis of the legs, bladder, and rectum will occur in a manner similar to what is observed in fractures lower in the dorsal region, and in the upper lumbar vertebræ.

Prognosis.—In spinal fracture accompanied by paralysis the prognosis is unfavorable. Many cases die from spinal meningitis and myelitis and from the exhaustion of bedsores and cystitis. Cases do at times recover, but usually with considerable disability from loss of power in the legs and imperfect control of the bladder and rectum. The lower the seat of fracture the better the chance of recovery both as to life and to function. In cases which finally prove fatal, life is the more prolonged as the site of fracture descends the spinal column. In patients who finally recover more or less completely, sensation usually returns in the palsied region before motion.

Treatment.—The management of spinal fracture usually resolves itself into catheterizing the bladder, preventing the occurrence of bedsores, and treating the spinal injury and inflammation in accordance with the rules laid down in the section on Diseases of the Nervous System. The patient should be transported and turned when in bed with great care. Especially in cervical fracture is this caution important, for there unexpected displacement from movement is more liable to happen. Sudden death from pressure upon the medulla may be thus induced. It has been suggested in fracture of the neck to keep the patient lying on his back with his head supported in a hollow made in a bag of sand. In fracture lower down gypsum jackets have been applied after etherizing and suspending the patient. The suspension gives an opportunity to

reduce the fragments by extension and direct pressure, and the jacket prevents subsequent displacement. The jacket is best made by soaking at one time several sheets of gauze cut the proper shape, in a paste of gypsum and water, and applying these layers around the trunk.

If displacement is discoverable and paralysis present, reduction of the displaced fragments by means of extension, rotation, and pressure is justifiable. Especially is this so because of the frequent impossibility of diagnosticating dislocation from fracture.

The urine should be drawn with a soft-rubber catheter three times in the twenty-four hours, beginning as soon as retention occurs, which is usually at once. The surgeon must look to this, for the patient will feel no pain from the distended bladder. The dribbling that takes place from overflow when the bladder is distended to its utmost may deceive the nurse, who will think the urine is being passed incontinently. This incontinence of retention calls for catheterization. Proper and early use of the catheter delays the advent of cystitis. When true incontinence occurs the catheter is no longer demanded. When cystitis has supervened the bladder should be washed out daily or every other day with warm water passed through a rubber catheter from a reservoir held a foot above the patient's abdomen. The solution may be medicated as is detailed in the section on Cystitis. Spinal fracture rarely gives rise to pericystitis, pelvic abscess, or sloughing of the bladder wall, but may do so.

Bedsores are to be avoided by using an air- or water-bed and keeping the patient clean. Careful turning to change the points of pressure is often essential. A cheap water-bed can be made by filling a trough with water and tacking a rubber blanket over the top.

Trephining, sawing, or cutting away the arches of the vertebræ for the purpose of removing pressure on the spinal marrow has been attended with some success, and should be adopted more frequently than has heretofore been the case. To a great extent the want of success is owing to the fact that the injurious pressure is often caused by the displacement of the vertebral bodies, which, being in front, are not easily reached; and to the circumstance that operative interference is delayed. Reduction by extension applied to the patient's shoulders and legs, and operative relief of spinal cord pressure should be undertaken immediately after the receipt of injury. Perhaps the cord may at times suffer pinching by a temporary displacement of the fragments at the moment of accident. In such cases operation would be of no service, because the bones have resumed their normal relations. Operation is always justifiable if the fracture is definitely located and there is no reason to suspect irrelievable displacement. It must be attempted under most rigid asepsis or antisepsis.

Bromide of potassium, cupping and ice to the spine, belladonna, ergot, iodide of potassium, strychnia, massage, counter-irritation, and electricity are therapeutic resources to be employed in accordance with the directions given under the treatment of Intraspinal Inflammation.

Fractures of the Cranium.

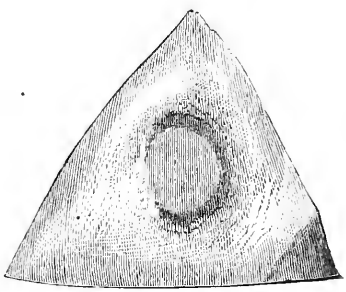
Pathology.—Cranial fractures differ from those of other regions in not being subject to displacement from muscular action; in requiring no retentive apparatus to maintain apposition of fragments, and in having no tendency to non-union. Their importance and interest, moreover, centre, not in the damage done to bone, but in the associated injury

sustained by the brain and its membranes. The cerebral injury may be contusion or laceration due to the same force that broke the bone; or it may be inflammation and irritation occurring secondarily to depression and splintering of the bone, and to bacterial infection through the fissures in the bone, or to overgrowth of callus at the time of repair.

It should be remembered that the walls of the cranium consist of two tables, separated by a greater or less amount of soft and vascular cellulated bony structure called the diploë. The inner table is nearly always more extensively broken than the outer, because the fracturing force, as a rule, is supplied from without inward. The greater shattering of the inner table is especially marked in comminuted fractures. The thinnest parts of the cranial wall are in the orbital, ethmoid, squamous, and inferior occipital regions. The frontal region is remarkable, after the age of infancy, for the existence in it of large cavities, the frontal sinuses, between the two tables of bone.

The prognosis in cranial fracture is favorable, provided the brain sustains no primary or secondary damage. Under opposite conditions death often occurs. Epilepsy and insanity sometimes follow as remote results, especially in fractures during childhood. Union is rather slow because the callus is furnished by the osseous tissue rather than the external periosteum and dura mater. As the bony tissue is not very spongy and vascular, the amount of callus is small; hence openings left by removal of fragments or after trephining are usually closed principally by fibrous tissue. The button of bone, if kept aseptic, may be replaced. It will usually unite with the surrounding bone and cause bony closure of the opening. The fracture may be a single fissure or a series of fissures traversing the cranium for a great distance, even running across several sutures. There is in such cases little or no separation or displacement of the edges. Separation of the sutures is sometimes caused by head injuries. This condition is practically the same as a fracture. Localized violence, if sufficient to cause fracture, gives rise, as a rule, to comminution of bone, and very often to displacement. This displacement is generally depression, though occasionally elevation of a fragment may be observed. The depressed portion may be attached to the surrounding bone along a part of its margin, thus having an oblique plane; or it may be driven in so deeply that separation of its entire circumference has occurred. One or more edges may be locked under the solid bone. Very frequently the edges of the fragments are bevelled, because the inner table breaks at a greater distance from the point of impact than the outer. This is a frequent cause of interlocking, and of consequent difficulty in elevating the depressed piece. A few cases of fracture of the inner table without fracture of the outer have been recorded. The diagnosis of such cases during life must be obscure, unless the symptoms of brain disturbance are sufficiently localized to justify trephining. Fractures of the outer table without breaking the inner may be produced where the bone is thick by any force only sufficient to drive the fragment

FIG. 156.



Repair by fibrous tissue after trephining.

into the soft diploic structure between the two tables. In children permanent depression of the bone may occur after injury without actual fracture. This is identical with what has been described as bending of bones and as green-stick fracture. It is probable that some osseous fibres at least are torn. Such a condition in the adult is unknown.

SYMPTOMS.—Fractures of the cranium, whether of the vault or base, show no special rational symptoms that may not arise from cerebral contusion, laceration, or hemorrhage without fracture. Marked depression of the fragments, however, can be perceived through an untorn scalp by palpation, as can the area of a greatly comminuted fracture which feels soft and is easily depressed by the finger and perhaps shows crepitus. Local subcutaneous emphysema in the mastoid region is diagnostic of fracture into the mastoid cells. A translucent, pulsatile swelling of the scalp is indicative of escape of cerebro-spinal fluid from the ventricles or subarachnoid space, and is conclusive evidence of solution of continuity in the cranial wall. It is, however, a rare phenomenon. Laceration of arteries may give rise to large fluctuating tumors under the scalp without any bone injury; but these are not translucent, nor as a rule pulsatile. Depressed fracture is often stimulated by the swollen and infiltrated tissues forming a hard ridge alongside of a softened and less elevated area of scalp. To the surgeon's finger this condition at times feels identical with a ledge of bone at the side of a depressed fragment. It must also be recollected that congenital depressions and irregularities from old injuries, periostitis, and senile changes may exist. When a wound is present the diagnosis is easy, for the fissure in the bone is easily recognized by a red line due to the blood staining the crack. This must not be confounded with the serrated lines shown by the great sutures, and the sutures around occasional Wormian bones. If the outer table is broken the inner one seldom escapes similar lesion. Brain tissue, cerebro-spinal fluid, and blood escaping from the interior of the skull may aid in establishing a diagnosis of fracture. Quite profuse venous bleeding, increasing in volume during expiration, does not prove that a meningeal vessel or sinus has been torn, for it may come from the vascular diploic bone tissue. Fractures of the base of the cranium can rarely be seen or felt by the surgeon's finger. There may be no special sign of the injury. At times, however, the escape of brain substance, blood, or fluid from the ear, nose, mouth or orbit, or the occurrence of paralysis of some of the cranial nerves may serve to confirm the diagnosis.

Bleeding from the ear, nose, or mouth to be of diagnostic value must be profuse and continuous; since limited bleeding occurs from damage to the soft parts in these regions. The appearance of blood at the external orifices of the head after laceration of an intracranial sinus, artery, or vein, is due to fracture of the bony walls of these cavities and rupture of the mucous membrane. In escape of blood from the ear the drum membrane is also ruptured. Sometimes, when the petrous portion of the temporal bone is broken, and the drum membrane not injured, the blood passes into the pharynx by way of the Eustachian tube, to escape by the mouth or nose, or to be swallowed and subsequently vomited. Marked extravasation of blood under the conjunctiva covering the eyeball, especially if it occur a day or more after the head injury, and it does not appear in the eyelids till some hours later, is very suggestive of fracture of the orbital plate of the frontal or sphenoid bone. Direct external injury to the eyeball and violent vomiting or coughing may also give rise to subconjunctival ecchymosis. So, also, may fracture

of the malar or upper maxillary bone. Signs of orbital aneurism, such as protrusion of the eyeball, pulsation, and murmur, suggest the occurrence of damage to the internal carotid artery or the cavernous sinus and make fracture of the cranial base probable. The late occurrence, after injury, of ecchymotic spots in the suboccipital region or below the mastoid process tends to confirm the diagnosis of basal fracture.

Discharge from the ear of an abundant, colorless, watery fluid, with little accompanying hemorrhage, especially if it occurs promptly after receipt of injury, and if the flow is modified by the position of the head and by coughing, is characteristic of fracture of the petrous bone and laceration of the tympanic membrane. It is cerebro-spinal fluid which will be found highly saline and almost destitute of albumin. The escape of watery liquid from the ear under other circumstances is of limited diagnostic value. It may be the liquid of Cotunnius from the internal ear, or blood serum escaping from a clot in the oral passages.

Cerebro-spinal fluid, in rare instances, may escape from the nose or mouth because of fracture of the spheno-ethmoidal portion of the base, or petrous fracture without rupture of the tympanic membrane. In the latter event the intact membrane prevents escape from the auditory meatus and the fluid passes into the pharynx by the Eustachian tube. Escape of cerebro-spinal fluid or abundant hemorrhage in basal fractures is an evidence of serious, but not necessarily fatal injury.

Paralysis of a cranial nerve occurring immediately after the receipt of a head injury may be due to laceration of the brain near the origin of the nerve or to hemorrhage within the nerve sheath. It is very suggestive, however, of fracture of the base with synchronous rupture, contusion, or compression of the nerve trunk. The pressure may arise from the existence of displaced bone or a large clot. The nerves most frequently subjected to such conditions in basal fracture are the facial, auditory, optic, and olfactory.

Treatment.—There has been until recently much discussion regarding the proper treatment of cranial fractures. Some surgeons opposed operative interference in the great majority of cases, while others believed that a more frequent adoption of trephining would give an increased ratio of cures. As death from the associated or induced brain lesion is common in fractures of the cranium, it is certain that the mortality will be decreased by early and more frequent antiseptic operations. Elevation and removal of bone with extraction of splinters of the inner table, removal of large clots, and incision even of the dura mater would avail nothing in cases where there has been serious contusion or laceration of the interior of the brain substance; but many cases undoubtedly die because peripheral lesions immediately adjacent to the site of fracture are untreated by mechanical means until the pathological process has advanced too far to be remediable. Fractures of the base are amenable to but little operative treatment, except that the nasal cavities and ears should be made aseptic and plugged with gauze impregnated with beta-naphthol, carbolic acid, or iodoform. The general treatment is identical with that proper in fractures of the vault, as is the operative treatment when the lesion is accessible.

The shock following head injuries is to be met by recumbency and the measures spoken of in the section discussing Concussion and Contusion of the Brain. Care must be taken not to continue a stimulating line of treatment after reaction has fairly begun, because the danger in these cases pertains to encephalitis, which is a possible sequence of the injury.

As soon as the condition of shock will permit, therefore, elevation of the head, cold to the scalp, low diet, perfect quiet, purgatives, and bromide of potassium (ʒij to ʒiv in twenty-four hours) should be insisted upon. Alcoholic stimulants should not be given unless the primary shock is profound, and then should be speedily discontinued. Shaving the entire scalp is a wise measure, since it permits more accurate examination for scalp-wounds and cranial depressions, and, in addition, renders the application of cold to the head more effective. A rubber bag or bladder filled with cracked ice, a coiled tube with cold water circulating in it, or cloths wet with ice-water, are easy methods of applying cold to the scalp. If ice is used, a degree of cold sufficient to freeze the skin might be obtained in careless hands. Retention of urine often occurs, and requires the use of the catheter. General bloodletting or cupping at the back of the neck may be necessary in the stage of inflammation. These questions, however, as well as the symptoms of traumatic inflammation of the brain, are all discussed under the head of Encephalitis, which should be referred to in this connection.

Opinions still differ somewhat as to what circumstances render it justifiable to convert, by incision, a closed cranial fracture into an open one, or to perforate the skull by trephine or saw and thus expose the dura mater. I look upon incision of the scalp and trephining as exploratory rather than therapeutic measures. In many instances the uncertainty as to the cranial lesion is more dangerous to the patient's life or future health than the conversion of a closed into an open fracture or the exposure of the encephalon by perforation of its bony wall. Improved methods of wound treatment have greatly lessened the risk from such operative procedures, but encephalitis is as fatal as ever. The symptoms denominated "compression of the brain" are probably the evidences of encephalic inflammation rather than of brain compression. As this inflammation is frequently due to injury from spicules of the inner table of the bone, to irritation from intracranial bleeding, or to septic infection, I prefer to eliminate by operation the possibility of this inflammation being due to local causes under the seat of fracture.

In punctured fractures immediate trephining to remove the depressed and splintered bone, to sterilize the wound, and thus to avert encephalitis, is advised by all authorities. This should be the line of treatment, even when no cerebral symptoms have developed. Punctured fractures are those open fractures with accentuated depression that result from blows inflicted by the corner of a brick, the point of a spike, or any very localized force that produces a puncture of the cranial wall with extensive splintering and driving-in of the inner table. Gunshot fractures of the cranium are, in my opinion, to be treated as punctured fractures.

The following tabulated statement gives my views concerning the proper treatment of cranial fractures. I admit that it is more heroic than that generally taught, but it has been written only after careful consideration of the reasoning of those who hold the opposite opinion to my own. Every case must be individually studied, and the patient's chances of death, of return to perfect health, and of life with subsequent epilepsy or insanity carefully weighed; but for a working rule to guide the student and practitioner, I think experience will show the indications given in the table to be correct. Trephining, properly performed, is in itself so free of danger that in a doubtful case the patient had better be trephined than allowed to run the risk of death, epilepsy, or insanity.

Syllabus of Treatment of Cranial Fractures.

Closed fissured fractures.	1.	Without evident depression.	Without brain symptoms.	No operation.
	2.	" " "	With " "	Incise scalp and trephine.
	3	With " "	Without " "	Incise scalp and possibly trephine.
	4.	" " "	With " "	Incise scalp and trephine.
Closed comminuted fractures.	5.	Without " "	Without " "	Incise scalp and probably trephine.
	6.	" " "	With " "	Incise scalp and trephine.
	7	With " "	Without " "	Incise scalp and trephine.
	8.	" " "	With " "	Incise scalp and trephine.
Open fissured fractures.	9.	Without " "	Without " "	No operation, and treat wound.
	10.	" " "	With " "	Trephine.
	11.	With " "	Without " "	Possibly trephine.
	12.	" " "	With " "	Trephine.
Open comminuted fractures.	13.	Without " "	Without " "	Probably trephine.
	14.	" " "	With " "	Trephine.
	15.	With " "	Without " "	Trephine.
	16.	" " "	With " "	Trephine.
Punctured and gunshot fractures.	17.	In all cases		Trephine.

In classes 3 and 11 I should be inclined to trephine if the depression was marked or the fissures sufficiently multiple to approach the character of a comminuted fracture.

In classes 5 and 13 I should trephine unless the comminution was found to be inconsiderable.

Operation, when decided upon, should be performed at once or certainly not delayed more than a few hours. All cases, whether trephined or not, should be treated as cases of incipient encephalitis.

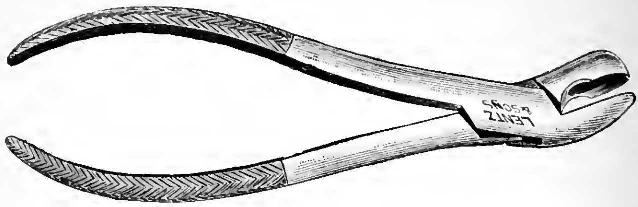
When careful study of the paralytic and other symptoms accompanying head injuries localizes the cerebral lesion near the seat of contusion of the scalp, incision is to be resorted to promptly, even if there is only a suspected fracture. If no fracture is found trephining should, as a rule, be performed, because it is probable that a hemorrhage has occurred either between the bone and dura mater or under the dura mater. Trephining will permit the surgeon to remove this source of trouble if outside the dura mater; if absence of pulsation or change in color of the dura mater is observed he should incise that membrane in the expectation of finding a clot beneath it.

The study of cerebral localization should be cultivated by all surgeons, for many cases of head injury would be treated much more successfully than is usually the case if the neurologist and surgeon employed their skill in combination. The symptoms and cranial lines by which neurologists locate brain lesions have been referred to in the section on Encephalitis, which should be read in this connection. Incision of the dura mater, aspiration of the brain substance, and the excision of brain tumors will become less unusual when all surgeons are familiar with the principles of cerebral localization.[1] In fracture of the cranium trephining is sometimes demanded by the paralytic and other symptoms localizing the lesion under the seat of fracture, when the amount of damage seen in the skull would lead one to abstain from operation. Hence cognizance of the significance of local palsies and spasms is demanded of the skilled surgeon.

[1] See Operative Surgery of the Human Brain, by John B. Roberts. P. Blakiston & Co., 1885.

Trephining.—Perforation of the cranium should usually be done by means of a slightly conical trephine, which is safer than the cylindrical instrument, except in the hands of one familiar with the operation. Holes of various shapes can readily be made by the flat-face burr of the surgical engine, but this apparatus is not always obtainable. Holes of any shape

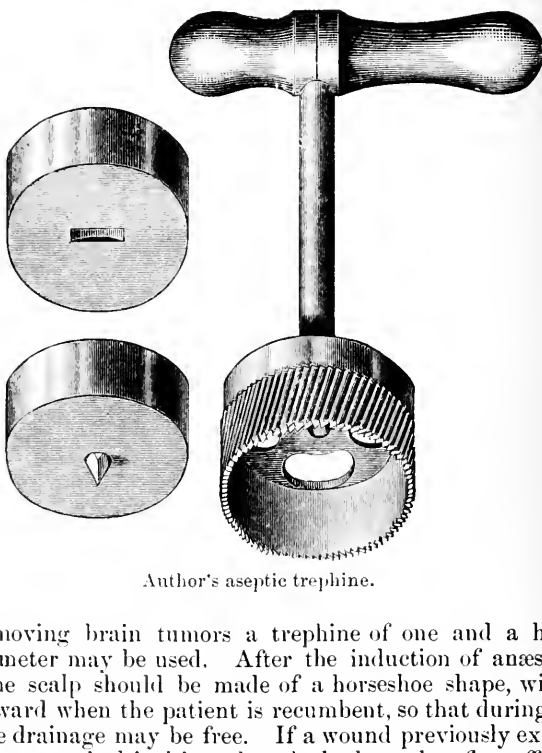
Fig. 157.



Hopkins's gnawing forceps.

and size can be made by enlarging a small trephine cut with the gnawing forceps. Since the usual object in cases of fracture is to get an opening through which to insert an elevator to pry up the depressed fragments, a small trephine should be employed. One not over three-eighths of an inch in outside diameter at the cutting edge is large enough. In opera-

Fig. 158.



Author's aseptic trephine.

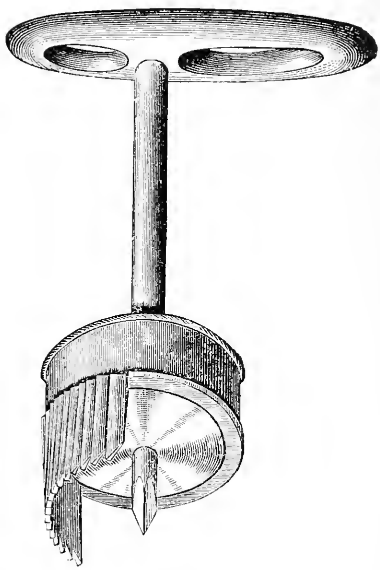
tions for removing brain tumors a trephine of one and a half to two inches in diameter may be used. After the induction of anæsthesia, the incision in the scalp should be made of a horseshoe shape, with its convexity downward when the patient is recumbent, so that during the after-treatment the drainage may be free. If a wound previously exists it may be enlarged by a conical incision, though the horseshoe flap affords better

exposure and should be made if the shape and position of the wound will permit. The knife should divide the scalp and periosteum at the same time in order that all the soft structures may be raised in one layer. If any periosteum remains attached at the seat of operation it should be pushed back with the knife handle.

In trephining for epilepsy, cerebral abscess or tumor the periosteum need not be removed except at the point where the crown of the trephine is applied. Indeed a circular incision in it the size of the disk to be removed is all that is needed. When the aseptic button of bone is to be replaced in the gap the periosteum upon its upper surface may then be utilized for holding sutures passed through it and then through the periosteum at the margin of the opening.

The crown of the trephine should be placed on the bone perpendicularly to its surface, but before its application the centre-pin of the trephine must be protruded about one-sixteenth of an inch. In fractures the instrument must be placed on solid and undepressed bone with about one-third of the crown overlapping the portion to be elevated. If the latter precaution is not observed, a bridge of solid bone will be left, which will prevent the application of the elevating lever. Elevation and extraction are often facilitated by removing a disk at the *least* depressed edge of the depressed fragment. The trephine should be semi-rotated from left to right and right to left, with moderate pressure against the bone. As soon as the groove is made sufficiently deep to maintain the cutting edge in position, the centre-pin is retracted lest it should perforate the inner table and membranes. The trephine is then reapplied and the groove cautiously deepened. When blood begins to flow it is evident that the diploic structure is being cut by the sawing edge, and additional care must be exercised, since the inner table is thin. In some skulls, however, the diploë is practically absent. After a few more half-turns have been made the trephine is removed, and the depth of the groove ascertained by carrying along it the point of a probe or pin. If the skull is of uneven thickness, as shown by the cranial wall being completely divided in one segment of the circle and not in the remainder, the trephine must be tilted toward the uncut side and cautiously rotated, or a segment trephine may be used. Very soon the disk is found to be loose, and is readily picked or tilted out by forceps or elevator. If the Roberts's aseptic trephine is employed there is less danger of sepsis because there is no centre-pin tube to retain bacteria. The disk is then dropped out of the crown instead of retracting the pin when a groove is cut.

FIG. 159.



Author's segment trephine.

The point of an elevator is then pushed under the depressed fragment, and used as a lever to raise the bone into place. Loose pieces and spicules

of bone are removed by the elevator or forceps; but care must be observed not to twist during extraction a large and interlocked fragment so as to lacerate the dura mater. It is better to saw away the ledge or point of bone interfering, or even to make a second trephine hole. There is usually in comminuted fractures one piece that acts as a keystone; when this is removed or elevated, the other fragments are readily managed. The Hey's saw and gnawing forceps do good service in cutting away corners of bone. Spicules driven into the membranes or brain should be searched for with the finger, and at once removed. Finally, all sharp edges of bone should be trimmed away, the wound washed with sublimate solution, a drain of catgut or rubber tube inserted, the scalp flaps sutured in position, and the gauze dressing applied. No metallic plate is ever used after trephining. The bone wound closes usually by fibrous tissue, the scalp wound heals as do other wounds of the soft parts. It is common now to replace all or some of the fragments of bone, in order that they may aid in closing the gap in the skull, by furnishing osseous tissue and inducing ossific deposition in the granulation tissue.

To accomplish this successfully, it is necessary that the fragments taken out be thoroughly cleaned in an antiseptic solution, of a temperature of about 105° F., and then kept warm in a similar antiseptic lotion, or between warm antiseptic cloths, until the moment before the flaps are to be sutured. The bony fragments are then laid loosely upon the dura mater and covered by the scalp tissues. This procedure is most successful in exploratory operations, because then there is less probability of the grafts being septic.

Incision of the dura mater, hypodermic puncture of the brain, or even incision of abscess in the brain, does not alter the method of procedure, so far as the preliminary trephining and after-dressing are concerned. The dura should, however, be sutured with catgut if large incisions have been made in it. The bone grafts can then be laid upon it; but provision should be made for removal of serous exudations and blood by drainage. The drainage tube or threads may be removed in thirty-six hours, if the wound is aseptic.

If it is possible to avoid doing so, the trephine should never be applied over the superior-longitudinal sinus, the lateral sinus, the torcular Herophili, or the middle meningeal artery where it grooves the anterior-inferior angle of the parietal bone. Hemorrhage from wounding these structures may prove very serious.

The removal of comminuted bone, however, may lay open these vessels. Bleeding from the artery may be arrested by ligation, by forcing a piece of wood into the bony canal, if there is one, or by seizing the vessel and the bone in a pair of spring forceps, which can be left in position for several hours. Hemorrhage from the venous sinuses may at times be controlled by forcing a little pad of absorbent gauze or sponge between the vessel and the overlying solid bone. Ligatures or a suture carried around the bleeding vessel by means of a needle should be tried when the hemorrhage persists. Trephining over the sinus, at a point a little distance from the wound, might be required to enable the surgeon to apply such a suture; but this event must be exceedingly rare. Hemostatic forceps may be left in situ until the first dressing is changed. In trephining over the air-cells in the frontal bone, called the frontal sinuses, a large trephine should be used to perforate the outer table, and a smaller one to bore through the inner.

Fractures of the Bones of the Face.

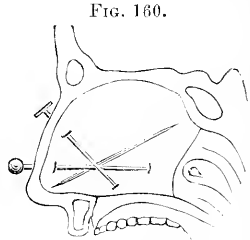
Fractures of the facial bones are usually the result of great direct violence; hence several of the bony components of the face may be broken by the same injury. Owing to the great vascularity of the parts, union takes place quickly and with the formation of but little callus. It is improper to remove splinters of bone which seem to have but slight attachment, for necrosis of such pieces is uncommon.

Fracture of the Nasal Bones and Cartilages.

Injuries of the nose producing fracture may involve, in addition to the nasal bones, the nasal processes of the superior maxilla, the frontal spine, and the perpendicular plate of the ethmoid upon which the nasal bones are supported. The cartilaginous septum is often bent or broken, and the lateral cartilages may sustain similar lesions, or be torn loose from the lower end of the nasal bones. The vomer likewise may be broken. It is said that fracture of the cribiform plate of the ethmoid may accompany fracture of the nasal bones. I can scarcely conceive of this occurring, unless the force was violent enough to cause fracture first of the frontal bone. Such instances are properly considered and treated as fractures of the cranium. In young children the arch made by the junction of the two nasal bones, may, it is said, be flattened from the suture opening on the posterior aspect. Blows received directly on the top of the nasal bridge would have this tendency.

Fractures of the nose are often comminuted, and attended with much swelling. The swelling, which rapidly appears, is liable to conceal the displacement, interfere with accurate diagnosis, and obstruct nasal respiration. Congenital deviations of the septum may deceive the surgeon. Emphysema of the face may occur from air escaping into the subcutaneous cellular tissue during efforts at blowing the nose soon after the injury. This symptom needs no treatment. Some suppuration often occurs, because the mucous membrane is torn and bacteria get access to the wound from the nasal chambers. Caries and necrosis are rather unusual, but may occur. Union generally takes place rapidly, and is complete within two or three weeks. If the fracture extends into the nasal processes of the superior maxilla, the lachrymal duct may become occluded by the displacement or by callus.

Fig. 160.



Author's method of pinning nasal septum.

The risk of permanent disfigurement is so great and union occurs so soon that careful examination and replacement should be instituted promptly, and, if necessary, under an anæsthetic. If the nasal bones are depressed, a narrow and rigid instrument, such as a grooved director, passed into the nostril will probably enable the surgeon to elevate the fragment. When there is a tendency for the depression to recur, a steel pin or needle may be thrust through the nose from right to left underneath the broken bone. A strip of rubber or adhesive plaster carried across the dorsum of the nose is then attached to the ends of the needle. Perforated shot may be clamped upon the ends of the pin to prevent

spreading and flattening of the nasal bridge. It is well to place a small disk of rubber on the pin, between the skin and the shot, to prevent ulceration and to maintain elastic compression. The pin should remain in position for about ten days. When a tendency to displacement of the cartilaginous portion of the nose is present, the proper conformation should be maintained by transfixing the cartilages with pins, and, by a sort of leverage action, pinning them in place. I have found this method effectual, after incising the deformed cartilage in cases of nasal deformity from fractures received many years previous to operation.[1] Plugs and canulas in the nostrils are uncomfortable, unnecessary, and inefficient. Cooling lotions may be applied to the fractured nose, if there are much pain and swelling. Patients should be cautioned against violently blowing the nose or snuffling, for displacement may thus be caused.

If profuse hemorrhage occurs, the nostril on the bleeding side should be plugged. The method recommended by Dr. R. J. Levis is the simplest and best. To the end of a strong string, about eight inches long, a disk of moistened sponge, about three-fourths of an inch in diameter and three-eighths of an inch in thickness, is firmly tied. This sponge is oiled, and, by forceps, pushed into the nostril and along its floor till it reaches the posterior nares. Upon the string hanging from the anterior nostril four or five similar disks of sponge are strung by central holes like beads, and consecutively crowded into the nose until the cavity is filled. After the lapse of twenty-four hours the disks are removed one by one. This method is much better than that accomplished by means of Bellocq's canula, and is applicable to idiopathic as well as traumatic bleeding.

Fracture of the Malar Bone and Zygoma.

These rare injuries are readily recognized by the deformity and the irregular outline, which can be felt by the fingers. If fracture of the malar bone extends into the floor of the orbit, the superior maxillary nerve may be injured, subconjunctival ecchymosis appear, or protrusion of the eyeball from intra-orbital hemorrhage take place. In fracture of the zygomatic arch the mouth may not open freely, because the displaced fragments obstruct the movement of the coronoid process of the lower jaw. Pain and swelling sometimes simulate or increase this disability.

The treatment consists in replacement by pressure of the fingers upon the cheek or within the mouth. If necessary, an incision may be made for the introduction of a lever under the displaced bone, or a screw may be fastened into the bony surface and used to pull the fragment upward.

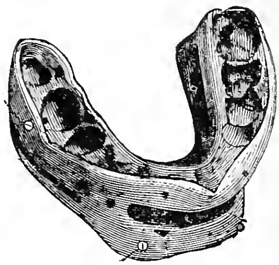
Fractures of the Superior Maxillary Bone.

The alveolar, nasal, and other processes of the upper jaw bone are the parts that most frequently sustain fracture. Even these injuries are uncommon, except fracture of the alveolar process during the extraction of teeth. The lachrymal canal, the orbit, and the superior maxillary nerve may be involved in the injury, with results similar to those described above under nasal and malar fractures. Union occurs in three or four weeks. Separation of the suture between the two superior maxillaries has been observed.

[1] See Cure of Crooked and Otherwise Deformed Noses, by John B. Roberts, Phila., 1889.

Examination of the surface of the face and of the interior of the mouth will disclose the nature of the lesion. In treating such fractures loose teeth should be left in place, for they frequently become firmly fixed again. Apposition can sometimes be maintained by keeping the teeth of the lower jaw firmly closed against those of the upper by means of Barton's bandage or a band of adhesive plaster passed under the chin with its ends crossed at the top of the forehead. Wiring the teeth adjoining the line of fracture is sometimes a good means of preventing motion.

Fig. 161.



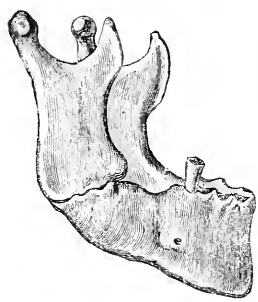
Gunning's inter-dental splint, with opening for introducing food.

The inter-dental splint, which is a mould of gutta percha or similar plastic material made to fit the grinding surfaces of the teeth of both jaws, will in most instances act sufficiently. It is placed in position, and the mouth kept shut by bandaging or adhesive plaster. Cork cut to fit the teeth in the same manner will answer a good purpose if no dentist is at hand to make the more complicated apparatus. During the three weeks that closure of the mouth is enforced, liquid food is introduced through the crevices between the teeth or by a tube passed between the alveolar arch and cheek as far back as the last molar. Inter-dental splints may be made thick enough to have a perforation for this purpose.

Fracture of the Inferior Maxillary Bone.

The lower jaw is more frequently broken than any other bone of the face. The seat of fracture is generally toward the anterior part of the body of the bone. Fracture of the ramus is comparatively rare, and fracture of the condyle and coronoid process even more unusual. The body of the bone is said to be weaker and more easily broken near the root of the canine tooth and the mental foramen than elsewhere. Loss of teeth and consequent atrophy of the alveolar process may reduce the normal strength of the bone in other situations, and be the predisposing cause of fracture. The most frequent seat of fracture, according to Gurlt's statistics, is near the middle line in front. These statements exclude from consideration mere splintering of the alveolar process often produced by pulling teeth and by other causes. Double fracture of the lower jaw is not uncommon.

Fig. 162.



Fracture of lower jaw behind teeth.

When the body of the bone is broken the fracture often communicates with the mouth through a tear of the gum. The fracture becomes in such cases, therefore, an open one, and is accompanied by suppuration because it cannot be kept aseptic. Suppuration is usually not very great, for drainage is free. The close attachment of the fibrous tissue of the gum to the alveolus is a sufficient explanation of this frequent complication. The inferior dental nerve

may be torn or bruised when its canal is involved in the fracture. Anæsthesia of the corresponding half of the lower lip and chin is the result of this nerve lesion.

The displacement and unnatural mobility in fracture of the body are easily detected, but the surgeon must bear in mind the possibility of malpositions of the teeth from irregular development and irruption. In single fracture of the body away from the median line the anterior fragment is apt to be displaced inward toward the mouth. In double or bilateral fracture of the body the middle or chin portion may be drawn downward by muscular action. The displacement in fracture of the ramus is more difficult of detection, but may often be recognized with the finger in the mouth.

Pain, often increased by motion or deglutition, and excessive secretion from the mouth are observed in fracture of the lower jaw. Perhaps the increase of saliva and mucus is largely apparent, the excess observed being really due to a want of proper control of these fluids within the mouth. Fetor from decomposing food, pus, and other secretions is often marked. Abscesses about necrosed pieces of bone, fistulous tracts, and ulceration of the mucous membrane may add to the discomfort of the patient, who perhaps becomes greatly debilitated by swallowing foul secretions and being deprived of a fully nutritious diet.

Union of ordinary fracture of the jaw takes place in five or six weeks. The prognosis, even in bad cases, is ultimately good. Even if teeth are lost the solid union which occurs gives a good basis for the adaptation of artificial teeth.

Fig. 163.

Barton's bandage for fracture of jaw.

Fig. 164.

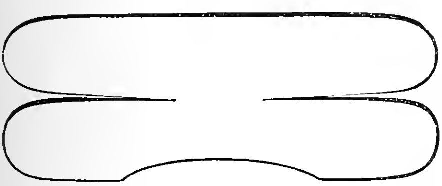
Garretson's modification of Barton's bandage.

Reduction of the fracture by pressure of the fingers on the teeth is usually easy, though occasionally comminuted fragments or displaced teeth may cause interlocking and require removal before correct apposition is obtainable. Teeth which are simply loosened should not be pulled unless they impede reduction. Tenotomy of displacing muscles is rarely necessary. The normal relation of the upper and lower teeth in most mouths is that the upper incisors come in front of the lower when the mouth is quietly closed. This should be recollected. Generally there is little tendency to displacement after ten days have passed. Hence after

the lapse of about three weeks the dressings may be removed, and the patient given an opportunity to attempt mastication cautiously in order to demonstrate whether the fragments have been adjusted in a manner to give the best use of the teeth in chewing. Any slight change in adjustment is then possible, for consolidation will not be complete. After reduction uncomplicated fractures of the jaw are to be treated by keeping the upper and lower teeth in contact by means of the Barton figure-of-eight bandage of the occiput and chin. The mouth must be cleansed with disinfectant washes of carbolic acid or beta-naphthol, tincture of myrrh (♏xv to f℥j of water) and similar drugs. Feeding, as in fracture of the upper jaw, is accomplished by introducing milk and soups through the crevices between the teeth, or by a tube passed behind the last molar or through the nostril. The hair and beard of men should be closely cut before these bandages are applied; otherwise they are apt to slip or be very uncomfortable.

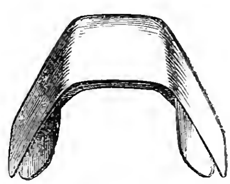
When the simple bandage does not give sufficient firmness to cause maintenance of correct apposition, or when the lateral pressure of the bandage causes overriding, it is well to adapt a moulded splint to the outside of the chin. Pasteboard, felt, leather, gutta percha, or gauze stiffened with gypsum are the proper materials from which to construct a hollow cap to fit the front and lower surface of the chin. The splint should extend on each side nearly as far back as the angle of the jaw; and may need a crescentic portion of its posterior edge cut away in order to avoid pressure on the throat above the larynx. The splint is padded and placed over the chin and held in position by the bandage. Before applying the bandage, the splint may be fixed in position by carrying a band of rubber adhesive plaster over the splint and as high up on the cheeks as the zygoma.

Fig. 165.



Original shape of gutta percha or pasteboard.

Fig. 166.



Gutta-percha splint moulded to fit chin.

If the tendency to displacement is persistent, wiring the fragments together or some form of interdental splint becomes necessary. A strong silver or iron wire may be fastened around several teeth on each side of the fracture; or in open fractures the ends of the bone may be drilled and wire sutures passed through. Interdental splints are splints worn inside the mouth and so fitted to the teeth and alveolus that motion at the seat of fracture is prevented. An impression of the teeth and alveolus is taken while the fragments are held in position. By means of this impression a splint of metal or vulcanized rubber is constructed which contains indentations into which the teeth accurately fit. If such a splint is applied to the teeth of the broken jaw and fixed so that the jaw bone is kept continually in close contact with it motion at the seat of fracture is impossible, because the crowns of the teeth are buried in indentations on the surface of the splint. There are several methods of securing the

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splint to the jaw. Probably the best is to have the upper surface of the splint fitted to the upper teeth. The jaws are then closed upon the splint and kept in that position by a Barton bandage. Lateral motion is prevented by the depressions into which the teeth fit. Such an interdental splint can be made thick enough to permit openings for feeding between the upper and lower surfaces of the splint. An illustration of this splint is shown above under Fractures of the Upper Jaw. Instead of using the upper jaw for immobilization the splints may be fitted to the lower jaw alone and attached by rods coming out of the corners of the mouth to a splint under the chin. A simple splint is made by softening a gutta-percha strip in hot water, moulding it to the crowns of the lower teeth so as to overlap the adjacent gum and hardening it by cold water. Such a splint may be fixed in position by wires carried by means of needles through the muscles and skin of the chin and twisted under the chin over small rolls of plaster or pieces of cork. In subjects who have lost all or nearly all their teeth interdental splints moulded to the atrophied gums present about the only efficient means of maintaining immobility. In all forms of splints greater immobility will as a rule be obtained by bandaging the jaws together. If desirable, gutta-percha wedges may be placed between the jaws on each side of the mouth in order to have a space in the middle for introduction of food. A crude form of interdental splint may be made of cork cut to fit the teeth of the two jaws.

Fracture of the Hyoid Bone.

The hyoid bone is rarely broken, and when sudden lesion is sustained the bone usually gives way near the junction of the great horn and the body of the bone. Fracture of the hyoid bone is at times associated with fracture of the laryngeal cartilages, and is due to similar causes, namely, pressure of the rope in hanging, grasping the throat by the fingers as in homicidal assaults, and direct blows upon the bone. The symptoms of hyoid fracture are sharp pain, increased by pressure, speaking, or swallowing; swelling, displacement and motion of the fragments, and crepitus. If the mucous membrane of the pharynx has been perforated blood will appear in the mouth. Sometimes the surgeon's finger in the pharynx will detect the displacement with ease. Coughing with paroxysms of choking or asphyxia may follow attempts at swallowing food or protruding the tongue. The treatment consists in replacing the fragments, keeping the parts quiet by prohibiting talking, and feeding the patient on liquids by means of a tube. Bandaging the throat is of no service.

Fracture of the Cartilages of the Larynx.

PATHOLOGY.—These injuries, owing to the exposed position of the larynx, are more frequent than fracture of the hyoid bone. They are at the same time more dangerous, because the intralaryngeal swelling is very liable to cause fatal asphyxia. Blows, falls, hanging, and homicidal throttling are the causes likely to produce laryngeal fracture. The mucous membrane is frequently torn, leading to extravasation of blood within the larynx and emphysema of the cellular tissue of the throat and neighboring regions. The upper horn of the thyroid cartilage is some-

times developed as a sort of epiphysis. Epiphyseal separation may then occur.

SYMPTOMS.—The symptoms are deformity, motion, and crepitation, accompanied by convulsive cough, alteration or loss of voice, dyspnœa, painful deglutition, and in many instances frothy, bloody, expectoration. The emphysema that is seen in many cases may spread over a large portion of the neck, face, and trunk.

In severe fractures death is common from suffocation due to subcutaneous hemorrhage, to free bleeding into the larynx, or to inflammatory or emphysematous swelling. The fatal issue may suddenly occur several days after the receipt of injury.

Repair occurs most probably by osseo-cartilaginous material.

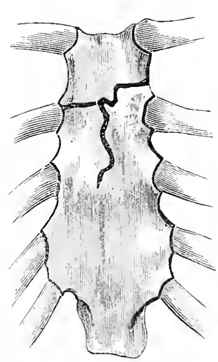
TREATMENT.—The treatment consists in remedies to allay inflammation, and cautionary tracheotomy, lest fatal obstructive swelling occur unexpectedly in the larynx. The opening thus made may be of value in giving the surgeon an opportunity to replace the broken fragments by the introduction of instruments into the air-passages. It is unwise to postpone tracheotomy until dyspnœa becomes extreme, since asphyxia may be sudden. The operation had better be done in all cases of severe fracture before the patient is left by the surgeon. A permanent tracheal opening is sometimes demanded after fracture of the larynx.

The tracheal rings occasionally sustain fracture. The diagnosis is often difficult, but if such injury is discovered it should be treated as fracture of the larynx by antiphlogistic measures and tracheotomy below the seat of injury.

Fractures of the Sternum.

PATHOLOGY.—This is a rare injury, probably because the sternum is protected from indirect violence by being connected with the elastic costal cartilages and ribs. When fracture occurs it is usually due to such great violence that associated injury to the ribs or thoracic viscera exists; but a direct blow of moderate force may, if limited to a small area, break the sternum. Violence which forcibly bends the spinal column backward or forward may give rise to sternal fracture in some cases, as it may cause vertebral fracture in others. Great muscular efforts, such as occur in lifting heavy weights or in parturition, have been followed by disruption of this bone.

FIG. 167

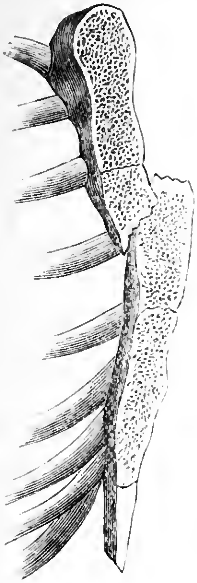


Fracture of sternum.

The first portion of the sternum, or manubrium, and the last portion, or ensiform appendix, often become united in adult life to the gladiolus, or central segment, by osseous material. In early life, and sometimes until much later, more or less perfect joints exist at these points. Therefore it is difficult and often impossible to say whether a given traumatic displacement is a fracture or a dislocation. Displacement between the first and second segments, the result of direct violence, may be diagnosticated as diastasis or dislocation rather than fracture when the patient is young. The symptoms confirmatory of this diagnosis are the half facets for the second ribs or a smooth upper facet being felt through the skin, the cartilages of the second rib being

out of place and easily reduced to position, and no crepitus being discoverable. In fracture the periosteum on the back of the bone is more likely to be torn, hence inflammatory involvement of the mediastinal structures becomes more possible. For this reason the differential diagnosis has some bearing on prognosis.

Fig. 168.



Transverse fracture of body of sternum. (Stimson.)

Sternal fractures are generally more or less transverse. Congenital fissure may be mistaken for longitudinal fracture, which is a very rare lesion. The frequent irregularities of the ensiform appendix must not be forgotten. Union usually occurs promptly, and little annoyance arises from uncomplicated fracture even if some deformity persists. Cases associated with rupture of the lungs or pericardium, or with profuse bleeding or consecutive suppuration in the mediastinum, are of grave prognosis.

Symptoms.—The symptoms of fracture of the sternum are displacement, mobility, crepitus, pain on motion, deep breathing or coughing, bloody expectoration, dyspnœa, and sometimes a stooping position of the shoulders because of the shortening of the breast bone. Replacement can best be accomplished by traction and pressure. If a hard pillow is placed under the patient's back and his trunk bent backward over it, the fragments can often be easily pressed into position. A deep inspiratory effort may assist the reduction. Recurrence of the deformity is not unusual. It has been proposed to screw a gimlet into the depressed portion of the bone, and thus pull it upward, or to insert an elevator or hook under it. These means increase the severity of the injury, but are justified by symptoms arising from pressure on the heart and lungs. Unfortunately the bone is rather too cancellous in structure to give a good firm hold for such instruments. Entering the mediastinal space or puncturing the pericardium or pleural cavity is to be deprecated. After reduction, if there is a tendency to displacement or much pain present, the chest should be immobilized by a broad bandage of flannel or adhesive plaster firmly applied, while the lungs are emptied by forced expiration. If intrathoracic symptoms arise, they should be treated on general principles. Pus behind the sternum should be promptly evacuated by incision along the side of the sternum or by trephining the bone. Stimson has suggested removing a disk of bone without disturbing the posterior periosteum, and then puncturing this with the aspirator needle, which may be passed in various directions until the suspected pus cavity is found or its existence disproved. Antiseptic incision of the posterior layer of the periosteum would seem to be better surgery. A post-sternal abscess may simulate aneurism because of its transmitting the cardiac pulsation.

Fractures of the Ribs and Costal Cartilages.

Pathology.—Fractures of the ribs are frequently met with in adults, but quite rarely in children. The greater elasticity of the bones and

costal cartilages in childhood sufficiently accounts for this difference. The occurrence of green-stick fracture may, perhaps, be often overlooked in chest injuries among children, and even in adults the periosteum at times remains almost intact, and thus obscures the symptoms of fracture. The protected situation of the first and second ribs behind the clavicle, and the mobility of the last two ribs, render fracture of these bones unusual. The ribs most commonly broken are the fourth, fifth, sixth, and seventh. Unless several ribs are simultaneously broken over-riding is impossible, for the adjoining ribs and the intercostal structures act as splints. Angular deformity is in the same way a good deal limited. Comminution, when great, changes the rigid thoracic wall into a flaccid membrane, moving in and out with respiration.

Direct violence, by driving the rib inward, causes fracture at the point of impact, and generally with inward displacement. Indirect violence, by depressing the chest, has a tendency to bend the rib and cause fracture, beginning on the external surface. Outward displacement is probably the more common deformity in these cases. Erichsen thinks that in indirect fractures the bone usually gives way near its angle, which is the point of greatest convexity. Direct injury, of course, will give rise to fracture in the anterior or posterior region, according as the violence is received upon the one or the other portion of the bone. Direct violence is more apt to cause splintering of the inner surface of the bone and inward displacement; consequently there is, under such causation, more likelihood of puncture of the viscera. Contraction of the extra-thoracic muscles during violent respiratory efforts, as in coughing or sneezing, may cause fracture of a rib. The rather frequent occurrence of broken ribs in connection with general paralysis of the insane is said to be due to trophic changes in the bones making them more brittle.

Injury to the thoracic or abdominal contents is not an infrequent associate of rib fractures. The most common indication of such injury is subcutaneous emphysema about the seat of fracture due to puncture or rupture of the pleura and lung. This is probably more frequent when the rib is broken at the situation of an old inflammatory adhesion of the pulmonary and costal pleura than when no such adhesions exist. When the wounded lung is previously non-adherent the air from the bronchioles and vesicles sometimes escapes into the pleural cavity, giving rise to pneumothorax instead of distending the subcutaneous cellular tissue and causing emphysema. The lung may actually become compressed and collapsed by large quantities of air and blood in the pleural sac. When the emphysematous condition spreads into the mediastinum and the interlobular cellular tissue of the lung the patient's condition becomes critical. Pericardial and heart injuries are infrequent except after very great violence. It is to be recollected that laceration of the viscera may occur without fracture of the ribs.

Laceration of an intercostal artery may happen even in fracture of a not very serious kind. If the fracture is open so that such injury and the consequent hemorrhage are detected, efforts should be made to secure the bleeding artery by passing a ligature around it. This can perhaps be done by a curved needle carrying a thread through the tissues in the intercostal groove on the lower margin of the rib, or by drilling the bone and passing a wire through it and around the vessel. The wound may be enlarged so that a small key can be passed in and turned in such a manner as to press on the vessel for a few hours. In some cases the centre of a square of muslin may be forced into the thorax so as to make a pocket

within the wall. Into this cotton should be pushed so as to make the inner part of the packing larger than the opening. If the corners of the piece of muslin are then pulled forward pressure will be made on the intercostal artery. In closed fractures an incision should be made and similar treatment adopted if the diagnosis of dangerous hemorrhage from a torn intercostal artery is made.

Symptoms.—The symptoms of uncomplicated fracture of the ribs may be so obscure that certainty of diagnosis is impossible. Green-stick fractures are scarcely recognizable except when a nodule of callus is developed at the seat of pain during recovery. Local pain induced or increased by pressure, motion, full inspiration, or coughing is suggestive of fracture, but may be due to mere contusion of the soft parts. Shallow or catching respiration is a common accompaniment of broken ribs and is due to the pain inflicted by deep inspiratory efforts. Cough is often present and has been attributed to reflex irritation from injury to the intercostal nerve lying in the groove of the bone.

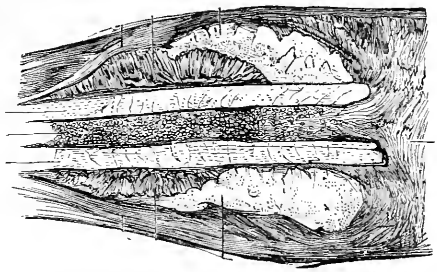
Pain or ecchymosis at a distance from the part of the chest upon which the violence was received is indicative of fracture. I have learned from Dr. R. J. Levis a manipulation that has often convinced me of the existence of fracture in obscure cases. If the patient lie upon his back and the surgeon make strong pressure upon the sternum and anterior part of the chest, pain will often be experienced at the point of fracture. This is due to the elasticity of the ribs and cartilages causing motion at the seat of fracture even when it exists at the lateral or dorsal aspect of the chest. If no fracture is present sternal pressure cannot give rise to pain at a distant part of the chest wall. Preternatural motion may be difficult to obtain and recognize, because of the normal mobility and elasticity of the thoracic parietes. Crepitation may be elicited by applying the finger-tips to the ribs on both sides of the suspected fracture and making alternating pressure. Motion also may be thus detected. Sometimes crepitation is more readily detected by laying the palm over the painful spot while the patient coughs or the surgeon makes firm pressure in the neighborhood of the injury with the other hand. Auscultation may detect crepitus when other means fail. Subcutaneous emphysema, which is shown by crackling when pressure is made upon the skin is an unmistakable sign of fractured rib and puncture of the lung. The development of a pleuritic friction sound or of a local pneumonia a day or two after injury, is very fair evidence of a broken rib. Bloody expectoration, pneumothorax, and serous effusion or hemorrhage into the plural sac are suggestive of fracture and simultaneous injury of the thoracic contents, but they may also occur from violence that does not break the elastic ribs.

The prognosis is good in ordinary uncomplicated fractures of the ribs. Union occurs in about four weeks by interosseous and insheathing callus which often leaves an irregularity, even when no displacement existed, because perfect immobilization is impossible. Sometimes when several bones have been broken bridges of callus unite the upper and lower borders. Hernia of the lung may occur if much displacement or comminution exists after severe fractures. The cellular emphysema in the great majority of cases is unimportant and soon disappears spontaneously. Great dyspnœa from sudden congestion of the lungs or pneumothorax is an important and at times a fatal symptom. Pleurisy, pneumonia, and pericarditis occurring as complications add greatly to the seriousness of the injury and should always be looked for by percussion and auscultation.

Recovery, however, is not uncommon after severe injury to the lungs and other viscera.

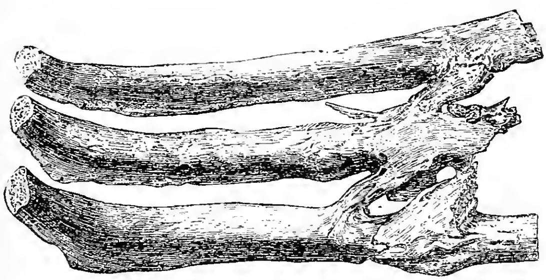
Treatment.—Fractures of the ribs should be treated by reduction of displacement and immobilization. At the same time the surgeon should be on the alert to avert or relieve intra-thoracic inflammation. Doubtful

Fig. 169.



United rib three months after fracture. (Holmes.)

Fig. 170.



Bridge of callus between broken ribs. (Holmes.)

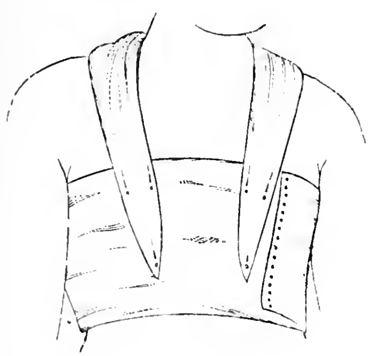
cases are to be treated as fractures. Pressure upon the ends of the fragments or upon the sternum may correct deformity and at the same time relieve the existing pain. Deep inspiration on the part of the patient may be of assistance. Occasionally, when overlapping exists the outer fragment may, by pressure, be sprung under the inner one, and its resiliency used to lift the latter outward into proper relation. If inward displacement were causing important symptoms it would be proper to introduce a hook or elevator under the depressed bone and thus bring it into position. In gunshot or other open fractures comminuted and detached pieces may at times be extracted with propriety.

Immobilization is to be effected by encircling the chest with a broad bandage so that thoracic breathing is restricted. The ribs are thus kept quiet and the patient required to breathe by the diaphraghm and abdominal muscles. The bandage should be made of a piece of flannel or muslin about eight inches wide and a yard and a half long, it should be applied and firmly fastened with pins during full expiration in order to be sufficiently tight. If the patient is ordered to raise his arms over his head and to

breathe out as much as possible, the girth-like bandage can be firmly adjusted. The gypsum dressing may be thus employed. If the patient has pain from the circular constriction it may be made looser or entirely dispensed with, since in order to avert pain the muscles will immobilize the parts pretty well without external assistance.

The bandage must never be carried much below the ensiform cartilage, lest it interfere with the play of the abdominal respiratory muscles. It may be prevented from slipping downward by bands carried over the shoulder. The arm of the adducted side should be bound to the chest or carried in a sling if the motion of the pectoral muscles gives pain. If, in comminuted fractures, displacement inward is caused by the bandage it must be removed. A laced jacket of stout linen, such as has been used in the Pennsylvania Hospital, is an efficient dressing for broken ribs. The dressing may be discarded in about four weeks. A broad sheet of rubber adhesive plaster or several overlapping strips of plaster may be used instead of the bandage. Before applying adhesive plaster all hair on the chest should be removed with the razor. In some cases constriction of the entire chest is very uncomfortable; this is especially so when the patient has asthma or chronic bronchitis. The adhesive plaster is then a preferable dressing, for it is easy to apply it to the injured side only, with the ends merely crossing the median line in front and behind.

Fig. 171.



Bandage for fracture of ribs.

Fig. 172.

Morton's jacket for fracture of the ribs.

The intra-thoracic inflammations require treatment similar to that indicated in similar lesions from non-traumatic causes. The cellular emphysema accompanying many fractures needs no special treatment, as the air is soon absorbed. The pressure of the bandage perhaps aids in its disappearance. Even when great extension of the emphysema occurs no danger is to be apprehended except when it gets into the mediastinum and interlobular tissue of the lungs. In such an event incisions in the skin or other operative interference could scarcely avail. Extreme congestion of the lungs, giving rise to grave dyspnœa, should be treated by venesection. Pneumothorax, hemorrhage into the plural sac, or large pleuritic effusion may demand aspiration or incision.

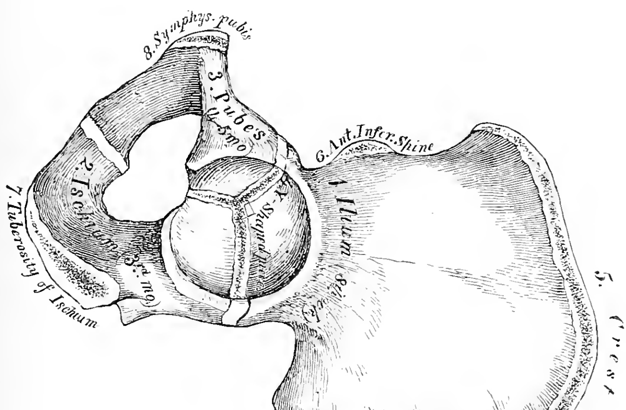
Fractures of the Costal Cartilages.

These injuries are said to happen most frequently near the junction of the cartilage and rib, and to occur in the seventh and eighth cartilages oftener than elsewhere. The partially ossified cartilages of the old are more susceptible of fracture than the cartilages of youth. Chondral fractures are usually transverse or nearly so, and are seldom complicated. Deformity is the most constant diagnostic symptom, though at times crepitus and mobility may be distinguishable. When it is impossible to determine whether fracture or dislocation of the cartilage has taken place the termination of the rib may be made out by acupuncture, for the needle will enter the substance of the cartilage. Union is accomplished not by cartilage, but by osseous or fibro-osseous tissue in much the same manner as in fracture of the ribs. The perichondrium seems to furnish the ensheathing callus. The treatment is the same as that for fractured ribs.

Fractures of the Pelvic Bones.

PATHOLOGY.—Fractures of the pelvis are rare, and require for their production a great degree of violence, except in instances where mere projecting processes are split or torn off. Falling embankments, railroad accidents, and the passage of loaded vehicles across the trunk are the kind of injuries liable to produce fractures of the pelvis. The fracture lines are apt to be multiple, because the crushing force which breaks the pelvic

FIG. 173.



Plan of development of innominate bone by three primary and five secondary centres. (GRAY.)

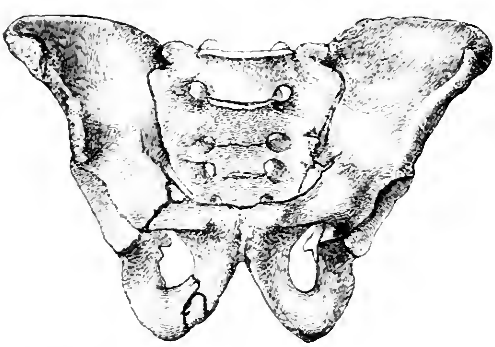
girdle brings strain at the same time on various parts. Separation of the pubic and sacro-iliac synchondroses or joints is not an unusual result of traumatism, and in young persons the epiphyseal lines of the innominate bone may be forced asunder by violence that in older persons would cause

fracture. The pubic, iliac, and ischiatic elements unite between the years of fifteen and twenty; the secondary centres at about twenty-five years.

The usual severity of the causative violence and the relation of the pelvis to the viscera render the prognosis as to life unfavorable. Laceration of the urethra, usually in its membranous portion, rupture of the bladder, rectum, colon, or small intestines; injury to the uterus; rupture of the iliac artery or vein; and contusion or laceration of the solid viscera are not at all infrequent complications. Death from secondary affections, such as suppuration in the cellular tissue of the pelvis or necrosis, must be recollected as a possibility. If no such complications occur, cure of even severe fractures takes place. Union may be expected in from six to eight weeks, but lameness is usual from more or less permanent disability of the muscles injured by the accident, or restricted in their function by the process of union or cicatrization. Deformities narrowing the pelvic canal may occasion serious difficulty in subsequent parturition.

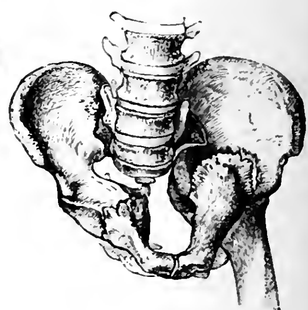
The character of fracture varies with the direction of application of the fracturing force. Sometimes the fracture lines are vertical, one or more passing through the rami of the pubes and ischium on one or both sides of the middle line and another through the iliac portion of the innominate bone into the sacro-sciatic notch. In the posterior segment of the circle the sacrum may be split vertically, or the sacro-iliac joint torn open. Lateral crushing may drive the head of the femur through the acetabulum into the pelvic cavity; or, if less severe, may produce lines of fracture radiating from the acetabular region. Parturition, forced abduction of the thighs, and direct external violence have produced separation of the symphysis of the pubes. The separation is said to occur between one of

FIG. 174.



Fracture through ramus of pubes and sacro-iliac junction.

FIG. 175.



Fracture of pelvis with head of femur forced through acetabulum. Autopsy several years after injury. (Bryant.)

the pubic bones and its attached cartilage rather than between the two cartilages which the joint contains. The gap felt through the integument may be as much as two inches wide. Occasionally the symphysis of the pubes and one of the sacro-iliac articulations have been torn open so that half of the pelvis and the corresponding leg have been markedly displaced upward.

Of the fractures which involve the continuity of the pelvic ring, that in the pubic region is most common, for here the bony constituents of the pelvis are most fragile.

Transverse or nearly transverse fractures of the sacrum or of the coccyx are occasional lesions. In both the tendency is for the lower fragment to be bent inward with its lower extremity pointing toward the interior of the pelvis. Dislocation of the coccygeal articulations is practically identical with fracture of the ankylosed bone.

Symptoms.—Displacement is not very great in the majority of pelvic fractures; but palpation will, if the parts are accessible, usually show either deformity, mobility, or crepitus. Vaginal and rectal exploration will be servicable in a few cases. Shortening of the lower extremity from upward displacement of the pelvis, and inability or indisposition to move the limb will at times aid in the diagnosis. Loss of support, fear of pain, and laceration of the muscles attached to the pelvis may all have part in the production of this disability. A good deal of subcutaneous extravasation of blood is frequently a feature of these injuries.

Careful observation of the relative position of the anterior spinous processes of the ilium will at times serve to strengthen or weaken an obscure diagnosis. Crepitus may be elicited and correction of deformity secured by traction on the lower limb. Escape of blood from the urinary meatus or rectum, retention of urine, bloody urine, and the rapid supervention of tympanites or peritonitis suggest the probability of fracture of the pelvis in cases with appropriate history.

In sacral fracture, paralysis of rectum, bladder, and legs, from complicating lesion of the sacral nerves, is said to be not unusual; and pain on coughing or defecation may be expected. Seizing the bone between a finger in the rectum and the thumb on the dorsum will probably demonstrate motion and crepitus, and perhaps correct displacement.

Coccygeal fracture occurs probably more frequently from parturient efforts and manipulations than from other traumatism. Rectal examination will often establish the correct diagnosis and reduce the displaced fragments.

Fractures of the crest or processes of the ilium are probably the least important of the fractures of the pelvic bones, for they have as a rule no serious complications, and confine the patient to bed for only a couple of weeks or perhaps not at all.

Mere fissure of the cavity of the acetabulum has no characteristic symptom.

Fracture of the rim of the acetabulum is worthy of consideration. It usually occurs as the result of great violence applied to the hip, and as an accompaniment of dislocation of the femur. Dislocation backward of the head, with breaking of the posterior and upper margin of the acetabular rim, is the ordinary form of the lesion. The symptoms are those of dislocation of the head of the thigh-bone with crepitus, and a ready recurrence of the dislocation after its reduction. Fracture of the neck of the femur may be mistaken for dislocation and fracture of the acetabular margin, because crepitus and recurrence of deformity are essentially marked symptoms in the former injury. In fracture, however, unless it is impacted, the limb assumes a position of outward rotation and extension, while in the posterior dislocations, which are the varieties likely to be seen here, the limb takes the position of inward rotation and flexion on the pelvis. Again, in fracture the trochanter is relatively nearer the anterior superior spine of the ilium than in dislocation. It is well in all cases of doubt to make sure of the actual position of the head, and also to remember that dislocation of the femoral head complicated with fracture of the neck of the bone is not impossible, and that

the crepitus attributed to fracture of the acetabulum may exist really between the fragments of the broken femoral neck.

TREATMENT.—The treatment of fractures of the pelvic bones varies with the location of the injury; but in all the severer forms of fracture the surgeon should at once introduce a catheter, in order that laceration of the urethra may be discovered, if it exist, before extensive extravasation of urine has occurred. Shock must also be treated. If the end of the catheter will not pass beyond the torn portion of the urethra into the bladder, a perineal incision should immediately be made. This incision should be made in the middle line and should open the tissues down to the seat of rupture, to which the end of the catheter left in place is a guide. Exit is thus given for the urine to pass from the opening in the urethra to the exterior, and disastrous extravasation into the perineal structures is averted. It is not proper to open the neck of the bladder unless the bladder itself is ruptured. The incision down to and into the urethra at the point of its rupture is all that is required to conduct the urine to the surface. The case should then be managed, so far as this feature is concerned, as one of external urethrotomy for stricture, by the occasional passage of a bougie. If a catheter can be introduced through the torn urethra into the bladder no incision is demanded, and the instrument, preferably a rubber one, should be retained in the bladder for a few days until danger of urinary infiltration has passed.

Violent manipulation may increase visceral damage in pelvic fractures and should be avoided, though careful efforts at correcting marked displacements are proper. Rest in bed in the dorsal, prone, or lateral position, according to the comfort of the patient, and support to the pelvis by encircling bands of adhesive plaster or by a broad girdle of muslin or flannel will usually meet the indications. All pressure liable to cause displacement or pain must be avoided by pads. A gypsum dressing may sometimes be serviceable. Continuous traction by weights attached to the leg and thigh as in fracture of the femur, may be the only means of preventing upward displacement in double vertical fractures on the same side of the median line. Fractures of the ischium may require pressure to be applied within the rectum in order to effect coaptation of fragments. The finger or a wooden lever may be employed. A few cases have been treated efficiently by means of packing kept in the rectum for a series of days to prevent recurrence of displacement. The packing, which should be enclosed in a rubber bag, must be occasionally removed to allow defecation and escape of flatus, unless a canula be placed through the centre of the distending apparatus. A rubber bag distended with air or water and well oiled, when inserted, would seem to be the most judicious means for effecting this seldom required intra-rectal pressure. In fractures of the iliac wings the encircling bandage must be omitted if it tends to press the fragments abnormally inward. In fracture of the tuberosity of the ischium the hamstring muscles should be relaxed by flexing the leg on the thigh, while the thigh should be extended or semi-extended at the hip. In instances of great comminution, followed by extensive suppuration, provision for free drainage should be made, and detached splinters of bone removed early.

The neuralgic affection, coccygodynia, whose symptoms are not unlike fissure of the anus, may be a secondary result of fracture of the coccyx. If subcutaneous division of the soft structure attached to the coccyx fails to relieve the pain, removal of the bone by means of the cutting forceps or saw, or with the burr of the surgical engine, may be performed.

Fracture of the Clavicle.

Pathology.—Direct violence and muscular strain, as in lifting heavy weights, may cause fracture of the clavicle. By far the most common cause, however, is indirect violence, for in falls upon the shoulder, elbow, or hand the force of impact is transmitted to the clavicle, which constitutes the only bony connection of the arm with the trunk. A tendency to exaggerate the curves of this doubly curved and doubly twisted bone is thus produced and the bone gives way as soon as the strain becomes too great. The mechanism of some cases of fracture is, it is said, a forcible bending of the clavicle across the first rib, with which it normally is often almost in contact. With the exception of the radius the clavicle is the most frequently broken bone of the skeleton.

The outer part of the middle third is the most common site of fracture, but from its obliquity the line may extend into the outer or inner third. The small diameter of the bone and the sharpness of the curve at this point, associated with the frequent causation from indirect violence, are satisfactory reasons for the lesion showing this preference.

Comminuted, multiple, or open fractures of the clavicle are rare. Green-stick fractures are common; and transverse breaks with little displacement or laceration of periosteum by no means unusual. Emphysema from puncture of the apex of the lung, paralysis from laceration or contusion of the nerve trunks, and lesions of the subclavian vessels are possible but almost unknown complications.

Fig. 176.

Deformity from fracture of clavicle united with displacement. (Hamilton.)

Fig. 177.

Fracture of clavicle.

Symptoms.—The usual deformity after the ordinary fracture of the middle portion of the clavicle is produced by tilting upward of the outer end of the sternal fragment, and displacement inward, forward, and downward of the inner end of the acromial fragment. The projection upward of the former has been attributed to the lifting force exerted by the outer fragment being thrust under it, and also to contraction of the sterno-cleido-mastoid muscle. The displacement inward, forward, and downward

of the acromial fragment is due to the fact that the clavicle is the support or stay which holds the scapula and its attached arm in proper relation to the thorax. When the clavicle is broken, the scapula, partly by reason of the weight of the arm and partly by the action of the great serrated and the lesser pectoral muscles, assisted, perhaps by the rhomboids, is rotated forward around the dorso-lateral aspect of the chest in such a way as to depress the acromion and carry it toward the anterior middle line of the trunk. This displacement of the point of the shoulder and the consequent relation of the clavicular fragments are well shown in the diagram adapted from Stimson. It represents in a schematic way the intact as well as the broken shoulder-girdle as the claviculo-scapular combination has been called. The inward and forward displacement of the acromion is seen at a glance. The downward deformity, being in another plane, is of course not exhibited. Shortening of the clavicle is great in oblique fractures with overriding, and may amount to one and a half or two inches. Sometimes, in transverse fractures, interlocking of fragments gives upward and backward angular deformity. In all fractures the continuance of the fracturing force after rupture of bone has occurred, and the line of break have influence in determining the amount and direction of the displacement.

Fig. 178.

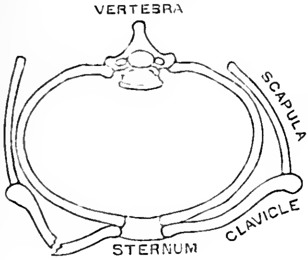


Diagram showing sliding forward of scapula and tilting out of its posterior border in fracture of clavicle.

Fractures of the outer third of the clavicle are often transverse, and, in reference to frequency, come next to fractures of the middle third. The displacement is believed by some writers to be greater as the line of separation approaches the acromion and gets outside of the attachment of the coraco-clavicular ligament. This, however, is denied by the high authority of Gurlt and Gordon. The deformity is usually angular, with the acromial fragment thrown forward.

In fractures of the inner third the most usual deformity is due to displacement downward and forward of the inner end of the acromial portion of the bone, or angular distortion of both fragments in the same direction.

The local deformity arising in fractured clavicle has been discussed; but in addition there is falling inward and forward of the shoulder, and projection of the inferior angle and posterior border of the scapula. This is an especially prominent feature of the injury when great overlapping occurs in lesions in the middle third of the bone. On account of the usually indirect causation of the injury, contusion, if existent, will be found on the shoulder, elbow, or hand, and not at the seat of fracture. Crepitus may not be perceptible until the shoulder is pressed outward and backward, so as to bring the ends of the overlapping fragments together. A loss of function, due to pain induced by movements, and not to mechanical obstruction, is shown in inability to place the hand on the head while the latter is held erect, or to raise the arm so as to hold it out at a right angle with the trunk. In green-stick fractures fixed local pain may be the single symptom, until, in the course of a fortnight, a small nodule of callus is perceptible. This condition must be discriminated from the localized pain and subsequent nodular deformity of syphilitic

periostitis. Fractures near the acromial end of the clavicle simulate dislocation.

The vascularity of the collar bone enables union to become quite firm by the end of the third week. Non-union is rare, and, when occurring, produces a very moderate degree of disability. Impairment of function from pressure of exuberant callus on the vessels and nerves behind the clavicle is a remote possibility. The paralysis sometimes attributed to such cause is oftener, perhaps, the result of injurious pressure of a large axillary pad used in treating the fracture.

Treatment.—Cure, without deformity, of clavicular fractures presenting much primary displacement, seems, with our present appliances, to be almost impossible. Fortunately the permanent distortion so often left is a cosmetic defect rather than a disability.

The probability of permanent deformity after complete fracture renders it wise to desist from too active attempts to straighten the bone of the green-stick fracture, for if complete separation is caused by the manipulation greater disfigurement is liable to occur. Straightening should, therefore, be attempted only with a moderate degree of force, especially as the bent bone may even regain something of its normal shape during the after-growth of the patient.

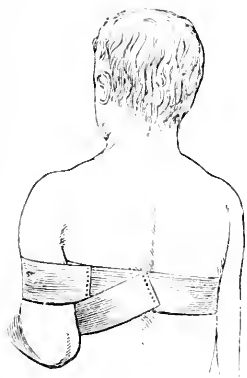
In complete fractures correction of deformity is to be attempted by grasping the *scapula* and swinging it around the posterior chest wall toward the median line of the back, and holding its lower angle against the ribs. This procedure tends to carry the acromion and head of the humerus outward and backward, and thus to restore the position of the shoulder, which has been changed by the loss of the support given by the unbroken clavicle. At the same time moulding of the fragments at the seat of fracture should be practised. A similar effect may sometimes be produced by standing behind the patient and pulling the shoulder backward with one hand, while coaptation is secured by pressure with the other hand at the seat of lesion. Good position is usually obtainable by these manœuvres. The difficulty in treatment arises from the impossibility of retaining correct apposition for three or four weeks by apparatus that can be tolerated by the patient and worn during walking.

Dorsal recumbency on a firm, level mattress, with the head bent a little forward by a small pillow and the injured arm laid and fixed by a bandage or adhesive strip across the chest with the elbows close to the ribs, is the best method of treatment. In this posture the weight of the body keeps the scapula pressed against the chest, and prevents it rotating forward. A bag of shot or sand may, if necessary, be laid upon the acromion to hold the shoulder more firmly outward and backward. The position of the arm also aids in maintaining coaptation and preventing over-riding. Few persons, except perhaps women who occasionally dress so as to expose the neck, care to maintain this irksome posture for several weeks, especially when informed of the fact that deformity, though unsightly, is not prejudicial to good use of the arm. Experience, however, seems to show that if this line of treatment is continued for ten days or two weeks the solidification of the fracture becomes such that the erect posture may be assumed, in conjunction with the ordinary fracture dressing, without any great tendency to reproduction of displacement. The best treatment for fractured clavicle, therefore, is the recumbent posture for about ten days, followed by the ordinary dressings, when the patient is released from his confinement in bed, for about three weeks more. When the least possible deformity is especially desirable, the recumbent posture should be

retained for three or four weeks. Continuous coaptating digital pressure could be maintained for several weeks, if necessary, to insure more absolute perfection in the result. The free administration of chloral and bromide of potassium will overcome the nervous restlessness which the requisite immobility of the trunk engenders.

When confinement to bed is objected to by the patient the dressing of Bryant, Sayre, or Velpeau should be adopted. Bryant reduces the fracture and then places a pad over the scapula below its spine and binds the bone firmly to the chest by strips of adhesive plaster, extending from the vertebral spines to the sternum. The arm of the injured side is then supported in a sling, with the hand drawn upward toward the opposite shoulder. Sayre uses two strips of adhesive plaster about three inches wide and one and a half to two yards long. At the end of one strip a large loop, with the back of the plaster inward, is made by stitching with a needle and thread. After the skin of the chest has been shaved, the injured arm is passed through this loop, which must be loose enough not to constrict the vessels. The elbow is then drawn well *backward* and fixed in that position by the free end of the plaster being carried around the entire chest from back to front, as shown in the illustration.

Fig. 179.



First stage of Sayre's dressing for fractured clavicle.

Fig. 180.

Sayre's dressing for fractured clavicle completed.

This end should also be secured by stitching, if there is any probability of the plaster slipping. The flexed forearm is now laid across the chest and the elbow carried *forward*, so that the loop of the first strip is made to act as a fulcrum. The middle of the second strip is then applied under the olecranon and the elbow forced upward by carrying the ends of the plaster along the forearm and across the back to the opposite shoulder. A slit should be made in this strip at the elbow, to relieve the olecranon of painful pressure, and pieces of lint should be placed under the forearm and in the axilla to prevent irritation from sweating. In cool weather this dressing may require no renewal during the time necessary to maintain immobility. If the fragments project upward notwithstanding the dressing, a compress may be placed upon the seat of fracture and held there by a short strip carried down the back and front of the chest. A pad of cloth, covered with plaster with the adhesive side outward, will stick to

the skin and not easily slip out of position. The hand may be left free, if desired, by passing the second strip along the ulnar side of the wrist. This lessens the discomfort of the dressing.

A good dressing in many cases is that of Velpeau. After placing the hand of the injured side on the opposite shoulder, a roller bandage is carried from the scapula of the well side obliquely over the back to the injured shoulder, over this, down the outside of the arm, under the elbow, across the chest to the opposite axilla and to the point of starting. When the arm has been well supported by several turns of this kind, the bandage is carried around the thorax and arm by circular turns from elbow upward. This dressing can be made more secure by coating it with silicate of sodium or gypsum, or by applying several narrow strips of adhesive plaster, about a foot in length, vertically over its folds.

Fig. 181.

Velpeau's dressing for fracture of clavicle.

A number of dressings for broken clavicle employ an axillary pad, with the idea that it acts as a fulcrum by which to force the shoulder outward. The pad is probably of little value unless too large and too firm to be worn with comfort and with safety to vessels and nerves; but it may, perhaps, be serviceable if so applied as to act as a compress upon the axillary border of the scapula and prevent sliding forward of that bone. It forms no part of any of the dressings recommended above.

In children the dressing for fractured clavicle should be continued for two or three weeks, in adults three or four weeks.

Fractures of the Scapula.

The mobility of the scapula and its environment by muscular masses protect it quite efficiently from fracture under ordinary forms of accidental injury. Fracture, when it does occur, is usually of the body, acromion, or surgical neck. The spine and the coracoid process also suffer fracture, but these lesions are of great rarity. The rim of the glenoid cavity is occasionally chipped off in dislocations of the head of the humerus, and the cavity itself may at times be fissured, but the obscurity of the symptoms renders diagnosis almost impossible.

In suspected fracture of the body, placing the forearm across the chest or behind the back will render the posterior border of the bone sufficiently prominent to enable the surgeon to detect deformity from displacement. Crepitus is best obtained, perhaps, by placing the palm of one hand over the scapula while the patient's arm is moved in various directions, or by the examiner insinuating his fingers under the inferior angle of the bone and endeavoring to obtain motion while he steadies the upper part of the bone with the other hand on the shoulder. The ridges sometimes so well marked along the borders and spinous process of the bone, must not be mistaken for fracture with displacement.

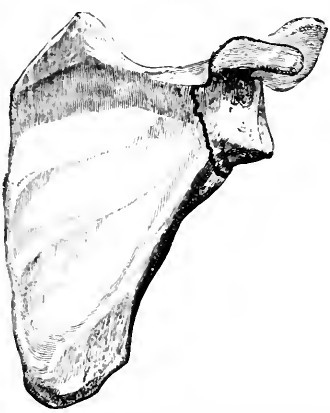
Reduction of the fragments may be difficult but should be attempted by pressure while the patient's arm is moved in various directions. Broad

adhesive strips carried across the scapula and partly around the thorax, and a bandage applied to raise the elbow and keep the arm against the side in a more or less vertical position, furnish an appropriate dressing. Union takes place in about four weeks and good use of the limb is to be expected, even if some deformity persists. In open fractures suppuration may occur from bacterial infection, and pus burrow under the scapula. This should be averted by furnishing facilities for drainage as soon as needed.

Fracture of the acromion and separation of the acromial epiphysis are lesions often indistinguishable. The two centres of ossification for the acromion appear about the sixteenth year, and ossification is complete between the twenty-second and twenty-fifth year. Hence, direct violence falling upon the elbow or muscular contraction may easily cause epiphyseal separation even in adults.

The line in acromial fracture is usually either in front of the articulation with the clavicle or at the root of the acromion process. Absence of deformity and contusion of the soft parts may obscure the recognition of the lesion. When the process is broken at its base much flattening of the shoulder is produced by the weight of the arm pulling the fragment downward and inward. Less deformity results when the mere tip is broken off. Inability to abduct the arm usually accompanies acromial fracture; and crepitation may be obtained by grasping the shoulder while the elbow is forcibly pushed upward. Fibrous is more common than bony union, probably because close contact of fragments is not obtained. The indication for treatment is to immobilize the arm with the head of the humerus forced well up against the scapula. Velpeau's dressing for clavicular fracture answers the purpose very well, and should be continued about four weeks. The least deformity is probably obtained by keeping the patient on his back in bed with the arm extended at a right angle to the trunk, in order to relax the deltoid, which is the displacing muscle.

FIG. 182.



Fracture of surgical neck of scapula according to Cooper.

FIG. 183.

Spence's case of fracture of the neck of the scapula. (GURLT.)

Fracture limited strictly to the constriction immediately behind the glenoid cavity, which has been called the anatomical neck of the bone,

is practically unknown. Fracture may take place, however, behind the coracoid process in a line passing downward from the supra-scapular notch, or in such a direction as to split off most of the head of the bone while leaving the coracoid process attached to the body of the scapula. These rare lesions are called fractures of the surgical neck of the scapula.

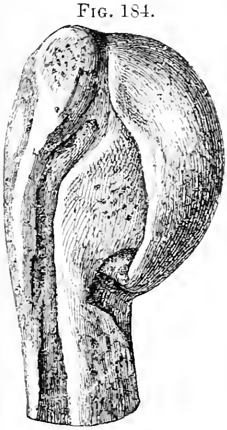
The flattened shoulder, prominent acromion, and loss of voluntary motion of the arm make the lesion resemble axillary dislocation of the head of the humerus; but the easy reduction and immediate recurrence of deformity, the crepitation and the absence of the humeral head in the axillary space, establish the distinction. The sinking of the outer fragment of the scapula with the attached humerus into the axillary space may mislead the careless surgeon into the belief that a humeral dislocation has occurred. The treatment resembles that for fracture of the clavicle, though an axillary pad to keep the arm out and steady the scapula is perhaps more essential in this instance. The downward displacement is to be antagonized by a short sling or bandage to lift the elbow.

Fractures of the Humerus.

These injuries are conveniently grouped as fractures of the upper end, fractures of the shaft, and fractures of the lower end of the bone.

Fractures of the Upper End of the Humerus.—The usual lines of fracture at the upper extremity of the humerus are through the anatomical neck and tuberosities; at the surgical neck, which is the constriction with indefinite boundaries seen below the tuberosities; and at the line of the main epiphyseal cartilage. Fracture of the surgical neck is

Fig. 184.



Fracture through tuberosities of humerus with head united to the shaft at a lower level than normal. (Stimson.)

Fig. 185.

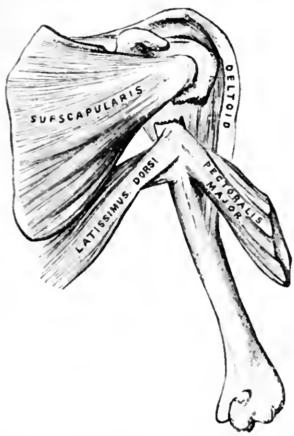
Specimen of fracture of the surgical neck of the humerus. (Bryant.)

the most common of these. Fractures of the head alone, of the anatomical neck alone, and of the tuberosities alone are possible injuries; but are too rare in occurrence and too difficult of exact clinical recognition to warrant discussion in this treatise. The existence of such fracture lines in conjunction with multiple splitting of the upper end of the bone is, of

course, not so unusual. Detachment of a portion of one of the tuberosities by muscular action happens occasionally as an accompaniment of dislocation of the head of the humerus; and is, in fact, a lesion very similar to what has been elsewhere described as "sprain fracture."

Fractures through the anatomical neck and tubercles frequently show little displacement, because the fragments are impacted or are held together by untorn periosteum. There is no evidence that fractures entirely within the capsule of the shoulder-joint fail to unite, or that the superior fragment acts as a foreign body and causes violent arthritis. Sometimes the lower fragment or shaft is drawn upward by the deltoid muscle in such a manner that the upper fragment or head becomes united to the former at a lower level than normal, and gives the joint the appearance of being the seat of an unreduced dislocation.

FIG. 186.



Diagrammatic fracture of surgical neck of humerus. (GRAY.)

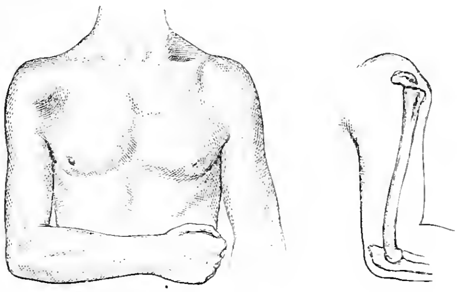
FIG. 187.

Separation of upper epiphysis of humerus. (MOORE.)

The surgical neck of the humerus is frequently broken and sometimes with but little displacement. Fissured lines may extend upward within the articular capsule, and impaction is not unusual. Displacement of the end of the lower fragment inward seems to be the most common deformity. Separation of the main epiphysis, which consists of the head and tuberosities, resembles in many respects fracture of the surgical neck; but only occurs previous to the twentieth year of life. When displacement occurs there is seen on the front of the shoulder, an inch or so below the acromion, a prominence which on palpation is felt to be a smooth, slightly convex end of bone, moving with rotation of the elbow. It is the upper end of the humeral shaft. Preternatural mobility and soft crepitus may be distinguished. Union of fractures of the surgical neck and of epiphyseal separations occurs in six to eight weeks, and is followed by good results if displacement has been corrected. The injury to the epiphyseal cartilage is sometimes, however, followed by arrest of longitudinal growth of the bone. Occasionally, the upper fragment is so rotated by the scapular muscles that its under surface looks forward and outward. In such cases apposition may often be obtained by abducting

the arm and carrying the elbow up alongside of head until the lower fragment becomes interlocked with the upper one. Coaptation will sometimes be maintained after this manipulation when the arm is gently depressed again.

FIG. 188.



Epiphyseal separation at upper end of humerus. (BRYANT.)

DIAGNOSIS OF INJURIES ABOUT THE SHOULDER-JOINT.—In investigating traumatic lesions in the vicinity of the shoulder, recognition of the fact that fracture exists is more important than a knowledge of the exact variety of fracture. The relation of the bony prominences to each other should be investigated and the correspondence of such relations with that on the normal side carefully established. Acupuncture needles may be employed in obscure cases to determine the location of the bony constituents of the joint. The surgeon should grasp the head of the humerus with the fingers of one hand while he rotates the arm by the other hand applied to the elbow. If a fracture exists between these two points the motion given to the lower end of the bone will not be transmitted to the head unless impaction has taken place. The same manipulation will in most instances of fracture develop crepitus, especially if some extension be used at the same time to draw the overlapping ends into contact.

In dislocation of the head of the humerus the shoulder will be flattened, the acromion very prominent and with a depression below it into which the surgeon's finger-tips can be pushed; the elbow will be abducted from the chest, the arm roated inward and the head of the humerus noticeable by palpation in its abnormal location, which is usually the axilla or the fossa just below the clavicle. In addition to these symptoms voluntary motion is lost; passive motion greatly restricted; it is impossible to place the patient's hand on the opposite shoulder while the elbow of the injured side is pressed close to the breast; the long axis of the humerus is not directed toward the glenoid cavity but internally to it; the head of the bone is felt to move when the elbow is rotated; no true fracture crepitus is developed, though a soft rubbing sensation may be detected, and after reduction the deformity does not occur on removing restraint from the limb.

When the head of the humerus is in its normal position the upper portion of a straight rod laid upon the outside of the arm from shoulder to elbow will be half an inch, an inch, or perhaps more from the edge of the acromion; but if the head is not in the glenoid cavity the rod will touch the acromion unless very great swelling of the soft parts happens to be present. The following test is given by Hamilton: Grasp the

top of the shoulder so that the commissure between the forefinger and thumb will rest upon the acromion just outside its articulation with the clavicle, and let the finger and thumb fall vertically downward. The anterior digit will, if the bone be in place, rest upon the centre of the head as it projects normally in front of the acromion, while the posterior digit will in a similar manner rest upon its less prominent posterior surface. If the surgeon will now move the patient's elbow forward so as to carry the head of the humerus backward, he will feel it press strongly against the posterior digit, thus conclusively proving that the head of the humerus is in its normal position, for if dislocation exists the humeral head cannot be so felt by this manipulation.

Fracture of the neck of the scapula with displacement is, according to Hamilton, the only injury that can simulate dislocation during the application of this test. Exclusion of this unusual fracture, therefore, renders the above tests diagnostic as to the existence or non-existence of dislocation. Fracture of the neck of the scapula is distinguished from dislocation of the head of the humerus by absence of rigidity during passive movement, which is almost unlimited; by crepitation, and by the immediate recurrence of deformity when pressure which has pushed the arm upward is withdrawn.

Fractures of the head and of the anatomical neck of the humerus are too infrequent and too obscure of diagnosis to require further mention than has been previously given. Fracture of the greater tuberosity is unusual also, except as a complication of dislocation.

In epiphyseal separation, which occurs not later than the twentieth year, the head of the bone can be felt in its normal position though it does not move with the shaft, the upper end of which lies in front or to the inner side of the head. Soft crepitation is perceptible when the separated surfaces can be placed in apposition, the elbow can readily be pressed close to the ribs, though the arm is directed somewhat outward and backward, and voluntary motion is lost, but passive mobility increased.

Fracture of the surgical neck is common, and is therefore the injury in this region which most frequently requires discrimination from dislocation. Displacement similar to that found in epiphyseal separation, the easy demonstration of the head of the bone in its normal position, preternatural mobility and crepitus unless impaction exists, and immediate recurrence of deformity upon removal or support, are the usual features. The symptoms of fracture of the surgical neck and of epiphyseal separation are very similar, and differ from those of dislocation in almost every particular except that in all three injuries voluntary motion is lost. In dislocation this is due to destruction of the articulation and the entanglement of the humeral head in its abnormal position, which circumstance gives an appearance of rigidity to the limb. In fracture or epiphyseal separation loss of active motion results from destruction of the lever through which the muscles act, hence occurs an appearance of helpless inactivity.

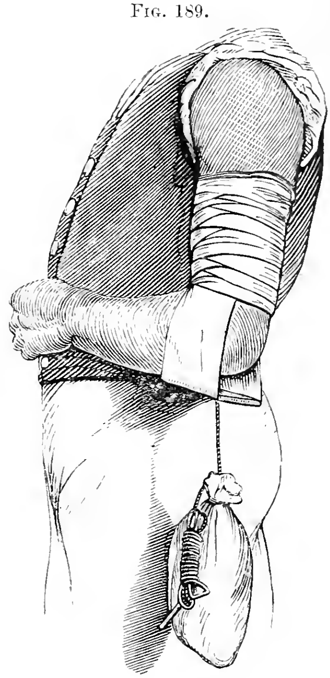
Any of these fractures at the upper end of the humerus may be complicated with dislocation of the scapulo-humeral articulation. The symptoms of the two lesions will then be a flat shoulder, prominent acromion, and abnormal location of the globular head, combined with abnormal mobility, crepitus, and deformity in the line of the bone. The freedom of passive motion and the ease with which the hand can be placed upon the opposite shoulder while the elbow is pressed to the ribs will differentiate the case from uncomplicated dislocation. When the accompanying

fracture is a mere detachment of the greater tuberosity these last two symptoms will not be present. When none of the injuries just detailed have been detected and fracture of the clavicle, acromion, or coracoid process also have been eliminated, the surgeon is justified in making a diagnosis of sprain or of contusion, for about the only other described injury is dislocation of the long tendon of the biceps, the very existence of which lesion is doubted by many.

Treatment of Fractures at the Upper End of the Humerus.—The result of these fractures, if of ordinary severity and if displacement is overcome, is usually good; though in rheumatic patients a certain degree of stiffness often remains for a long time, even when the joint has not been invaded. The treatment of fractures of the head, anatomical neck, and tuberosities consists in simple restraint of motion, induced by carrying a broad strip of adhesive plaster or bandage once around the arm and chest and placing the hand and wrist in a sling. Violent movements to verify a probable diagnosis should be avoided, as any impaction existing may thus be destroyed with the unfortunate result of increasing displacement. In four to six weeks treatment may be discontinued.

Other fractures at the upper end of the humerus are best dressed by filling up the hollow of the axilla with a folded napkin or thin compress, and then, after replacing the fragments, securing the arm against the chest with the elbow carried a little forward. In this manner the thorax acts as a splint to which the arm is bound by means of adhesive plaster or a bandage. The forearm may be laid across the opposite mammary region as in treating fractured clavicle, or may be simply supported in a sling which should preferably be applied near the wrist in order that the weight of the elbow may furnish some slight extending force. The shoulder-cap splint is usually a useless and unnecessary complication. When it is deemed necessary that greater extension should be exerted a weight may be attached to the elbow by an extension apparatus of adhesive plaster such as is used for continuous traction or extension in fracture of the femur. In the event of the upper fragment being so rotated outward that coaptation cannot be maintained unless the lower fragment is carried upward and outward, it becomes necessary to treat the fracture with the arm strongly abducted. This may be done by using a triangular splint, of leather or other firm material, with a rounded apex. The apex should be pushed well up into the axilla and the legs of the triangle fixed to the side of the chest and inner aspect of the arm respectively. Another method is to put the patient in bed and by means of an extension apparatus of adhesive

Fig. 189.



Method of applying extension in fractures of the humerus. (Hamilton.)

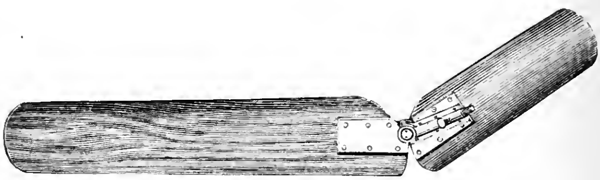
plaster, a pulley and a weight to obtain continuous abduction and extension of the limb. An elastic cord properly attached to the wall of the room will answer the same purpose as the weight. Counter-extension can be exerted by elevating the foot of the bed or by fastening the patient to the head of the bed by adhesive plaster attached to the chest and shoulder. In such instances the arm usually has to be kept at an angle with the long axis of the trunk of from 30 to 45 degrees.

The dressing may be discontinued in ordinary cases of fracture of the upper end of the humerus in five or six weeks.

Gunshot and other open fractures involving the shoulder-joint may demand excision, but conservative antiseptic measures and secondary excisions have of late years displaced to a great extent primary excisions. In fractures complicated with dislocation an attempt to reduce the dislocation should be made at once. If this is found impossible, the fracture should be treated and renewed efforts at reduction made subsequent to union of the fracture. If there is definite evidence that such late efforts will be unavailing, even with the advantage of leverage gained by the united bone, endeavors to prevent union and create a false joint at the seat of fracture are justifiable. The disability due to old fractures complicated with dislocation may sometimes be lessened by excision of the head or the upper end of the lower fragment.

Fractures of the Shaft of the Humerus.—Fracture from muscular violence is more common here than in any other part of the skeleton except the patella and olecranon. Displacement in fractures of the shaft depends more on the breaking force than the action of muscles. The usual characteristic symptoms of fracture are present and easily determined. Involvement of the vessels and nerves in the injury is not so very uncommon. Wrist-drop from palsy due to pressure upon the musculo-spiral nerve, and gangrene following vascular damage, must not be hastily referred to improper treatment. Union occurs among children in three or four weeks, among adults one or two weeks later. Delayed union and non-union happen more frequently than in other long bones; and is possibly accounted for by the difficulty of completely immobilizing the limb when the fracture is treated with the elbow flexed.

Fig. 190.



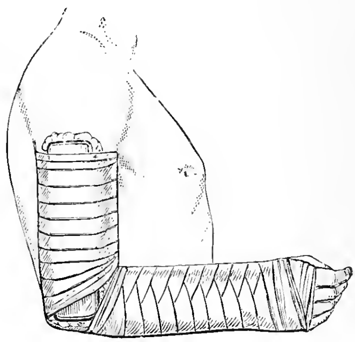
Internal angular splint with changeable angle.

In treating these lesions the surgeon should be especially on the alert to overcome rotary displacement. Such deformity can be detected by observing that a line drawn from the greater tuberosity to the outer condyle is not parallel to the long axis of the bone as it should be. When much swelling is present, and when a suspicion of complicating injury of vessels or nerves exists, it is wise to keep the patient in bed a few days and employ simple support by pillows and cushions, lest the more constricting dressing be accused of producing gangrene or paralysis. Few fractures of the shaft require continuous extension by weight from the elbow. Frac-

tures in the upper half of the shaft are well treated, as are fractures of the upper end, by using the lateral thoracic wall as a splint. The thin axillary pad, described in this manner of dressing, may act better if somewhat wedge-shaped and placed with its base downward.

In lesions of the lower, and sometimes in those of the upper half, an internal right-angle splint, with or without an external concave splint of pasteboard, leather or gutta percha, makes a good dressing. The internal splint should be well padded at the elbow or have an opening in it to prevent pressure on the internal epicondyle. The elbow should not be drawn upward by the sling used to support the forearm. Sometimes an external angular splint, reaching from acromion to wrist, is preferable. At other times a *straight* external splint from shoulder to wrist may be found more effective in restraining motion at the seat of fracture, because it better immobilizes the elbow-joint. The forearm should be semi-prone when this dressing is employed. The gypsum dressing is often satisfactory after primary displacement and swelling have been removed. When adopted it should be applied, with the elbow flexed, from the hand to above the shoulder with a few turns of the saturated bandage passing around the upper part of the chest. A forearm sling completes the dressing.

FIG. 191.



Splint for fracture of shaft of humerus. (BRYANT.)

FRACTURES OF THE LOWER END OF THE HUMERUS.—The principal fracture lines which may occur at the lower end of the humerus are shown in the diagrams. In addition, the small tubercle on the external condyle, sometimes called the external epicondyle, may be detached, and in very rare instances a portion of the articular surface of the bone may be chipped off. Of course, comminuted fractures following no definite lines may occur here as elsewhere in the skeleton.

FIG. 192.

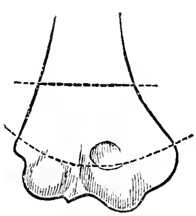
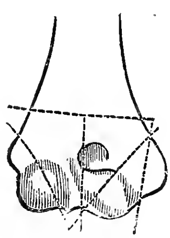


FIG. 193.



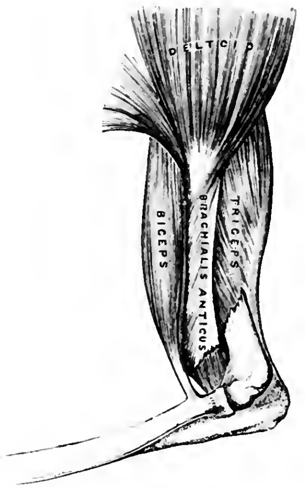
Principal fracture lines of lower end of humerus.

In studying injuries about the elbow, it should be remembered that there is no lateral motion between the humerus and the bones of the forearm. When the elbow is semi-flexed an apparent lateral motion is observable. It really takes place at the shoulder and not at the elbow, which is a hinge joint alone. Flexion and extension of the joint proper and rotation of the head of the radius are the only possible motions of

the healthy articulation. Lateral mobility at the elbow means fracture or some other organic change in the constituents of the joint.

Fracture above the condyles may be mistaken for dislocation of the bones of the forearm, and if complicated with vertical splitting may involve the elbow-joint. The most frequent displacement is projection of the

FIG. 194.



Diagrammatic supra-condyloid fracture of the humerus. (GRAY.)

upper fragment in front of the lower with angular deviation in the line of the limb. This, if uncorrected, will greatly impair the future utility of the joint. It is the prominence given the olecranon by this displacement that creates a resemblance to dislocation. The normal relation of the olecranon to the condyles, the natural character of the joint motions, the crepitus developed when extension is exerted on the limb, and the recurrence of deformity, establish the diagnosis.

Separation of the main lower epiphysis, which, though small, includes both condyles, is rare. In deformity, diagnosis and treatment, the injury differs little from supracondyloid fracture. This conjugal cartilage ossifies about the sixteenth year. The prominent tubercle on the internal condyle, called the epitrochlea or internal epicondyle, may be the subject of epiphyseal separation or be broken off with or without a small portion of the bone at its base. The line of fracture is entirely without the limits of the joint; hence, the articular motions are unimpaired unless by spasm or fear of pain. Downward and forward displacement of the fragment occurs when its fascial envelope is sufficiently disturbed to permit the influence of muscular traction. Simultaneous injury to the ulnar nerve lying in the groove behind the epicondyle is possible. Abnormal mobility and crepitation are easily detected by grasp-

FIG. 195.

Epiphyseal fracture of lower end of the humerus. (BRYANT.)

ing the tubercle in the fingers. This, which is likewise developed by a distinct ossific centre on the outer condyle, may in rare instances be detached.

Fractures separating either of the condyles from the shaft necessarily involve the joint, and hence are very important injuries. Such fractures

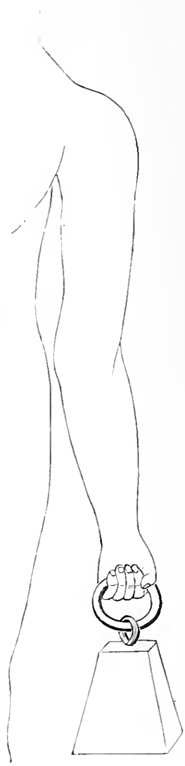
Fig. 196.

Fracture above condyles of humerus. (Stimson.)

Fig. 197.

Normal angle of bones of forearm. (Allis.)

Fig. 198.



Outward deflection of forearm. (Stimson.)

are common. The essential components of the elbow hinge are the ulnar and the articular surface of the internal condyle. Hence, fractures of the inner condyle are especially dangerous to the future integrity of joint mobility. The ulnar joins the humerus in such a way that the axes of the two bones form a divergent angle. This outward deflection of the forearm gives the "carrying function" to the limb, by which the hand when hanging by the side is enabled to carry burdens without striking the thigh. Loss of this angle by ascent of the internal condyle or descent of the external condyle after fractures, greatly impairs the usefulness of the limb. Such displacements are very common, because the line of fracture usually runs obliquely from the margin of the base of one condyle down into the articular surface of the same. The condyloid fragment in fracture of the inner condyle is usually displaced upward and backward, and drags the attached ulna with it, thus destroying the divergent angle at the elbow. It is said that a quarter-inch displacement upward will destroy this angular deviation. The anterior or posterior right-angle splint often used to dress this fracture is accused, by Dr. O. H. Allis, of Philadelphia, of being a frequent cause of this deformity. He probably is right. He says that such a splint bandaged upon the flexed elbow tends to raise the ulna till it lies on the same plane as the radius, while it normally lies below that bone when the elbow is bent. The displacement in fractures of the outer condyle is often

upward, thus increasing the outward angle at the elbow; but the radius with the attached condyloid fragment may, according to Allis, be forced

Fig. 199.

Fracture of internal condyle. (Hamilton.)

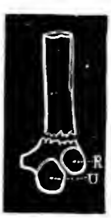
Fig. 200.

Fracture of external condyle. (Hamilton.)

Fig. 201.

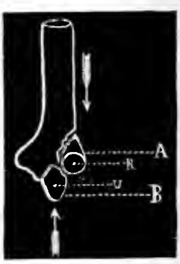
Deformity after fracture at lower end of humerus. "Gunstock deformity." (Allis.)

Fig. 202.



Epiphyseal separation or fracture above condyle, showing possibility of deformity by tilting the lower fragment. (Allis.

Fig. 203.



Fracture of external condyle showing similar possibility of deformity. (Allis.)

down by rectangular splints till it reaches the level of the ulna, so as to cause a loss of the divergent angle at the elbow. Dr. Allis thinks that

Fig. 204.

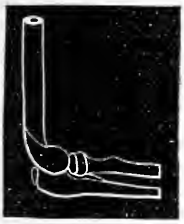


Fig. 205.

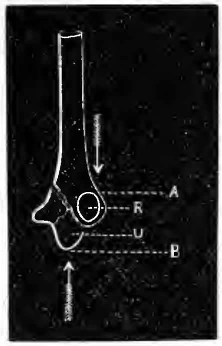


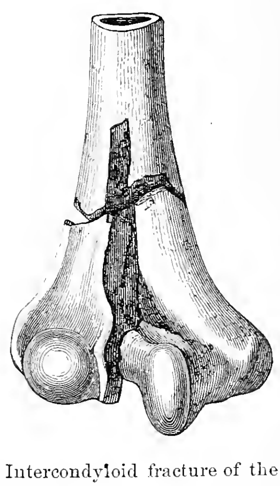
Fig. 204.—Differing planes of radius and ulna. (Allis).

Fig. 205.—Relation of radius and ulna to humerus in fracture of internal condyle, showing ease with which ulna and broken condyle can be forced up by splint and bandage, and thus destroy carrying function of arm. (Allis.)

epiphyseal separation and fractures above the condyles may show similar distortion from the use of rectangular splints. Condyloid fractures are occasionally associated with partial or complete dislocation of one or both forearm bones.

The existence of mobility and crepitus is to be determined by grasping the lower end of the humerus and the suspected condyle with the fingers of the two hands and endeavoring to move the condyle alternately backward and forward. In the fully extended normal articulation a line joining the two epicondyles crosses the tip of the olecranon, but as flexion is made the olecranon sinks below this line. The position of the head of the radius, one-half inch below the external epicondyle, should also be recollected in order to differentiate dislocation of this bone. If the surgeon places a finger at this point and then rotates the patient's hand, the head of the radius will be felt rolling under the integument. The transverse diameter of the lower end of the humerus is usually increased in condyloid fracture, because of the obliquity of the line of fracture and the common tendency in both fractures to upward displacement; but it is often difficult to be certain of this widening. When backward displacement has occurred after fracture of the internal condyle the prominent olecranon during flexion and the disappearance of this projection during extension greatly resemble backward dislocation of the bones of the forearm.

Fig. 206.



Intercondyloid fracture of the humerus. (Stimson.)

Union of condyloid fractures occurs in four or five weeks, but unreduced displacements, masses of callus, and the sequences of secondary synovitis often leave much functional disability.

The term intercondyloid is applied to those fractures in which the condyles are split apart and at the same time are separated from the shaft. The fracture lines may be exceedingly diverse in direction, but in simple cases assume an irregular **T** or **Y** shape. In intercondyloid fractures, which are, however, not very common, the joint is, of course, implicated; and very often great damage to the soft parts co-exists. Separation of the condyles with the olecranon forced up between them is a not unusual displacement. Great distortion of the joint, increased width of the lower end of the humerus, and crepitation when the fractured surfaces are brought into contact render the diagnosis evident.

Diagnosis of Fractures at the Lower End of the Humerus.—The points in the diagnosis of fractures of the lower end of the humerus need recapitulation. Normally, the head of the radius is about half an inch below the external epicondyle, and unless the shaft of the radius is broken moves when the hand is rotated. With an extended forearm the two epicondyles and the tip of the olecranon are on a level, but as the elbow is flexed the olecranon sinks below this horizontal line.

Supra-condyloid fracture with the ordinary backward displacement of the lower fragment shows unusual projection of the olecranon and triceps tendon, increased by straightening the elbow; correction of deformity when traction is made upon the forearm, with recurrence of the same when the traction ceases and the elbow is bent; motion and crepitus above the joint; free mobility at the joint which may, however, be limited by swelling or spasm; normal relation of olecranon and epicondyles. In backward dislocation of the bones of the forearm the unusual projection of the olecranon and triceps tendon is diminished by straightening the elbow, and the point of the olecranon rises above the level of the epicondyles; when the deformity is reduced there is a distinct snap and recurrence of distortion does not readily recur; no motion or crepitus can be developed above the joint, though joint frictien may simulate fracture crepitus; the normal articular movements are almost abolished and the joint is fixed, though some abnormal lateral motion may be possible; the relative position of the epicondyles and olecranon is altered; the head of the radius is not in its proper situation; the distance between the epicondyles and the corresponding styloid processes at the wrist is decreased; and the lower end of the humerus feels smoother and wider than the lower end of the shaft in case of fracture.

When the lower fragment is displaced forward the question of diagnosis is easily settled, because forward dislocation of the forearm is exceedingly rare and the symptoms characteristic.

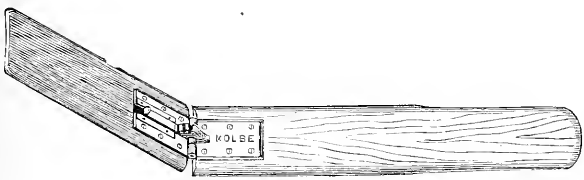
Fracture of the internal condyle is diagnosticated by crepitus and independent mobility; lateral mobility at the elbow-joint when the forearm is extended; and in addition, when displacement is present, change in the divergent angle of the elbow and alteration in the horizontality of the line drawn across the back of the articulation joining the epicondyles and olecranon. If dislocation of the head of the radius coexists, the head of that bone will probably be discovered behind the external condyle, and the internal condyloid ridge of the humerus will be felt to terminate abruptly at the line of condyloid fracture. In fracture of the external condyle, crepitation, independent mobility, alteration of the normal lateral deviation of the axis of the limb at the elbow, change of relation with the other condyle and olecranon, but normal relation to the head of the radius, will serve to indicate the nature of the lesion.

The relation to the head of the radius should be carefully studied when outward dislocation of the radius and ulna is a question to be determined.

In suspected intercondyloid fractures, great deformity with distortion of relation of the bony landmarks, increase in width of the lower end of the humerus, independent mobility of the condyles and between the condyles and shaft, and crepitation, especially noticeable when the olecranon is drawn down and the condyles pressed together, are the symptoms to be sought.

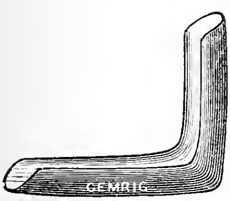
Treatment of Fractures at the Lower End of the Humerus.—It has been the general custom for the most part to treat these fractures in the flexed position with anterior or internal angular wooden splints, or with posterior angular trough-like splints, made of felt, tin, gypsum, or similar material. This is usually an error. The best results will generally be obtained by keeping the joint extended or nearly so during the time that displacement is likely to occur. Ankylosis in the extended posture

Fig. 207.



Anterior angular splint, with changeable angle.

Fig. 208.



Posterior angular trough.

Fig. 209.


Deviating splint for fractures through the condyles of the humerus.

is, I admit, very undesirable, but, unless *permanent* ankylosis is very certain to occur, disability from the "gunstock" deformity is to be guarded against by keeping the joint extended. Fractures of the epicondyles, some fractures of the external condyle, fracture of the internal condyle with backward luxation of the radius and ulna, and bad intercondyloid fractures, may perhaps give better results when the flexed position is adopted, but for the great majority of cases the extended posture is better. The dressing, then, for fractures at the lower end of the humerus consists of a straight wooden splint, twelve or fourteen inches long, placed upon the anterior surface of the arm and forearm, with a little extra padding at the bend of the elbow if complete extension of the joint is not desired. The application of a moulded gypsum splint to the anterior or posterior surface, or to the entire circumference of the arm, is sometimes preferable. Four weeks or less is usually long enough to retain the splint upon the limb. In all cases the surgeon should see that the outward deflection of

the forearm, due to the obtuse angle between the axes of the arm and forearm, is maintained. It is usually best to have the straight splint cut so as to make a slight outward deflection between the arcs of the upper and lower portions. I have often made such splints from a strip of board with my pocket-knife. It is well to compare the patient's arms, as the normal outward deflection varies in individuals. If the position of extension is uncomfortable, or if there is reason to believe that *permanent* ankylosis is about to occur, the straight splint may be removed at the end of two weeks and the elbow carefully flexed to nearly a right angle. Should the fragments remain in good position and no tendency to recurrence of deformity be present, the subsequent treatment may be conducted with an angular splint.

In very bad intercondyloid fractures and fractures involving the radius and ulna as well as the humerus, ankylosis will almost certainly occur; hence the flexed position here should be adopted more frequently than in other cases. Continuous weight-extension may become necessary to keep the fragments in position. Excision of the joint may be demanded in such fractures, if open. It is better in such excisions to avoid, if practicable, removal of the upper ends of radius and ulna, because otherwise the insertions of the great muscles are disturbed. Passive motion should not be made before the end of three or four weeks, and not then if it causes pain. The moderate stiffness, usually left even in favorable cases, will disappear in the course of a few weeks after removal of the splints, especially if active and passive motions accompanied by friction be employed. If inflammatory involvement of the joint has taken place early passive motion will do no good but probably much harm.

Fractures of the Bones of the Forearm.

Fracture of both bones of the forearm near the middle is quite common, but fracture of the shaft of either bone alone is unusual. When the radius alone is broken the lesion is nearly always situated near its lower end, while the ulna when broken alone nearly always suffers such lesion at the upper end.

The clinical phases and the diagnosis of fractures of the forearm will be better appreciated if lesions of similar parts of the ulna and radius are discussed together.

Fractures near the Elbow-joint.—Hence I shall speak first of fractures near the elbow-joint. This is the method adopted by Stimson in his elaborate work on fractures, from which, I may say in passing, much of the material used in this section on fractures has been obtained.

Fracture of the Olecranon.—Direct violence may cause the olecranon to be broken from the shaft of the ulna, but it is probable that a great majority of these fractures are due to a leverage action consequent upon the triceps holding the process firmly against the lower end of the humerus at the time the impinging force is applied to the forearm. The bone snaps in such cases as a stick is broken by the hands across one's knee. Muscular contraction alone seldom causes this fracture. The location of fracture varies, but most commonly is near the middle of the process, where there is a narrowing. The epiphyseal cartilage, which ossifies about the sixteenth year of life, is placed near the middle of the olecranon; therefore, supposed fractures in young persons may really be

instances of diastasis or epiphyseal separation. The triceps muscle tends to displace the upper fragment upward, but the process is so attached to the humerus by ligaments, and the tendinous expansion of the muscle so unsheathes it and the adjacent part of the ulna that not much separation occurs unless the forearm is flexed. In fact in many instances no marked displacement takes place even in flexion, because the fragments are bound together by the untorn aponeurosis. Under the opposite conditions a separation of as much as two and a half inches is said to be possible, but this probably refers to the joint in a flexed or semiflexed position. The intra-articular effusion that frequently arises and the tendency of the biceps and anterior brachial muscles to draw up the forearm, and thus crowd the humerus into the gap between the ulnar shaft and olecranon, probably have an influence in causing separation of the fragments.

Fig. 210.

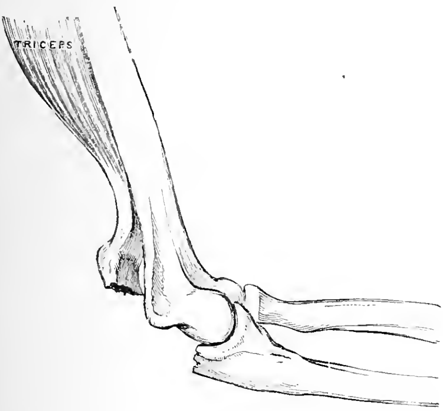
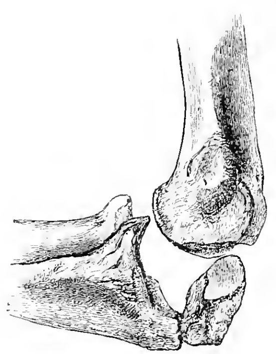


Fig. 211.



Diagrammatic fracture of olecranon. (Gray.)

Fracture of olecranon. (Erichsen.)

The symptoms are localized pain and swelling, lateral mobility and crepitus, combined with more or less loss of power to extend the forearm, and with, in some cases, a noticeable depression at the seat of fracture. The last two symptoms vary greatly with the degree of laceration of the fibrous envelope of the bone. The development of crepitus may require the fully extended position of the joint in order to obtain contact of the bony surfaces. If local pain and impaired extension power alone are present, the case should be treated as an instance of fracture until the subsequent history disproves the suspicion.

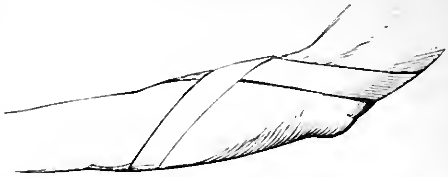
Union may be bony, but is generally fibrous. A comparatively long fibrous bond gives but a moderate disability, if there coexist no adhesions of the olecranon to the humerus and no intra-articular fibrous obstruction. This is due to the fact that powerful and extensive flexion is a more important function of the elbow than complete extension. Ununited fracture is not very infrequent.

In ordinary cases cure takes place in about four weeks, and though the joint is necessarily involved, there is no tendency to ankylosis of the elbow.

When separation of the fragments is present the injury should be treated with a splint to keep the elbow extended to that degree which is seen when the arm hangs passively at the side. As ankylosis is not to

be anticipated, the most accurate coaptation possible is to be sought. This is obtainable only by the extended posture; but the extension must not be so excessive as to bend the joint backward, which is possible when the normal check to such motion given by the olecranon is destroyed by frac-

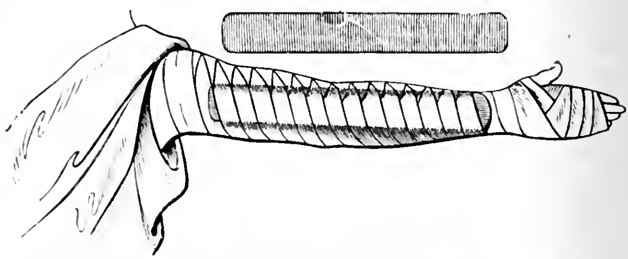
Fig. 212.



Adhesive strip applied to steady olecranon. (Agnew.)

ture. The upper fragment may be steadied or pulled down if necessary by a strip of adhesive plaster so applied above it that the ends cross each other upon the forearm. An anterior straight splint of wood or metal or a circular gypsum dressing, leaving the elbow uncovered, is then applied from the upper third of the arm to the lower third of the forearm. If

Fig. 213.

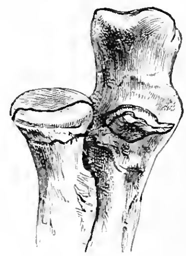


Fracture of olecranon treated in extended position. (Agnew.)

it is impossible to bring the fragments together by extension alone, the upper fragment may be drawn down by a single steel hook, similar to Malgaigne's double patella hooks, inserted into the tendon just above the olecranon and attached below to the skin and fascia covering the ulna, or to the gypsum dressing which is applied to keep the elbow extended. Tenotomy of the triceps tendon would be justifiable to overcome upward displacement. The hook should not be applied for three or four days until the inflammation immediately following the injury has subsided, but should be retained in position for four weeks. If there is much primary synovial effusion into the joint, increasing displacement, aspiration is proper. When violent reaction occurs and ankylosis seems probable, passive motion may be cautiously made after three weeks, but is to be omitted if it causes inflammatory reaction. When there is little tendency to separation and flexion does not increase the displacement, the limb may be treated in a semi-flexed position if extension causes discomfort. When great disability has resulted from long fibrous union, great improvement has been obtained by exposing the bone, freshening the ends, and fastening the fragments together by wire sutures introduced so as not to penetrate the joint. This procedure is justifiable under exceptional circumstances if done antiseptically.

Fracture of the coronoid process is very rare except as a complication of backward luxation of the ulna or of radius and ulna together; when the process is liable to be broken off by being driven against the articular surface of the humerus. The symptoms are the presence of a small movable body in the line of the tendon of the anterior brachial muscle, crepitation, and usually the symptoms of dislocation of the forearm. Displacement from muscular contraction is impossible, unless the line of fracture be below the base of the process, for the tendon is not inserted upon the apex of the coronoid process. A similar reason proves the supposed detachment of this apophysis by muscular contraction an error. Treatment consists in immobilization with a splint or the gypsum bandage for a couple of weeks with the elbow flexed at a right angle or less. A sling should then be worn for ten days or two weeks longer.

Fig. 214.

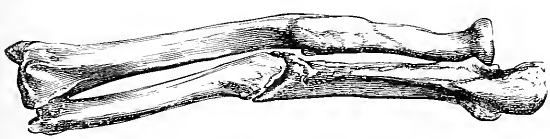


Fracture of coronoid process, and head of radius. (Bryant.)

Fractures of the Head and Neck of the Radius.—Of these rare injuries little is known. A splitting off of a part of the articular surface of the head with the line of fracture running down the neck is perhaps the most common form, and is observed in connection with coronoid fracture of the ulna. The fracture may be entirely within the joint; hence synovitis and defect in bony union might be expected. Loss of power of rotation, crepitation, the presence of a movable fragment, and an apparent widening of the head of the radius are the symptoms likely to aid in the diagnosis. The radius may also be broken at the neck just above the bicipital tubercle. Immobilization for three or four weeks in the flexed and supine position, which relaxes the biceps, should be the treatment.

Fractures Near the Middle of the Forearm. *Fracture of the Shaft of Both Bones.*—When the radius and ulna sustain simultaneous

Fig. 215.



Union, with slight lateral displacement, of fracture of radius and ulna.

fracture of the shaft it is usually found that direct violence has caused the injury; and as a rule the radial fracture is nearer the elbow than is the ulnar fracture. Fractures from muscular contraction are occasionally seen. Green-stick fracture is not uncommon. Angular displacement toward the interosseous space, overriding and rotary displacement of the radius are sources of deformity. The overriding may shorten the limb two or three inches. When the radial fracture is above the insertion of the round pronator muscle, the short supinator and the biceps, which is also a supinator, have unopposed action; hence the upper part of the bone is supinated, and the lower portion, if it is kept pronated by the splints will unite with rotary deviation. To avoid this the hand should be kept supine by the splints.

The loss of rigidity of the limb, crepitus, and abnormal mobility render the diagnosis easy. Union occurs in about four weeks, but a high grade of inflammation is not an infrequent complication. Gangrene from constricting dressings must be remembered as a possible danger, to which attention may not be called by any discomfort felt by the patient. The comparative frequency of these complications probably arises from the usual causation of the fracture by direct violence. The primary bandage under the splints is to be especially avoided in these injuries. When the two fractures are directly opposite each other, when great laceration or irritation of the interosseous membrane and fibrous tissue has occurred, and particularly when inward angular deformity is permitted to remain uncorrected, normal pronation and supination are liable to be diminished or destroyed by an osseous bridge soldering the radius and ulna together, or by a protuberance of one or both bones. The prognosis in uncomplicated cases is good, though delay or failure in union is not very infrequent. After replacement of the fragments has been obtained by extension and counter-extension and by pressure of the fingers in the space between the two bones, the limb should be placed in the supine position, that is, with the palm of the hand upward, and so maintained by splints until consolidation has occurred. The semi-supine position is often adopted, but as full supination is required to prevent rotary deformity of the radius when it is broken above the insertion of the round pronator, it is safer to teach the adoption of complete supination for all cases of fracture of the shaft. Such a position gives between the radius and ulna almost, if not quite, as much space as the semi-supine position, and hence is as efficient in preventing loss of rotation by bridges of callus.

Fig. 216.

Angular displacement and union between bones in fracture of radius and ulna. (Stimson.)

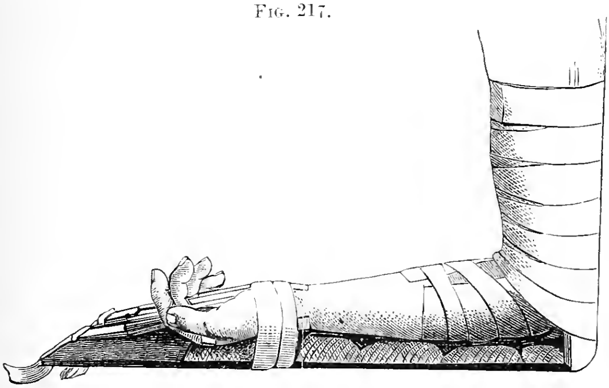
The supine position is most conveniently maintained by the use of either a right angle wooden or metal splint applied to the flexor surface of the limb from the middle of the upper arm to the root of the fingers, or a right angle trough similarly fitted to the extensor surface of the arm and forearm. A straight palmar and dorsal splint applied together and extending from elbow to fingers will scarcely prevent the limb assuming the semi-supine position, which is more convenient and comfortable to the patient than complete supination. After partial consolidation has occurred, say at the end of two weeks, the two straight splints may be substituted for the angular one, since at that time the risk of rotary distortion is no longer great. In fractures below the insertion of the round pronator such splints may be used from the beginning of the treatment, but must be wider than the arm so that the bandage shall not press the bones together at the site of fracture. The palmar splint is made more comfortable by having the distal end cut off obliquely and well padded for the fingers to close over it.

In all these fractures the sling should be broad enough to support both hand and forearm. A narrow sling supporting one part only is liable to permit sagging and angular deformity. This is especially so when the

palmar and dorsal splints are employed. The use of a narrow compress under the splint to prevent encroachment of the fragments upon the interosseous space is either unnecessary or inefficient. The circular gypsum dressing is not well adapted to these fractures, though the moulded gypsum splints are not objectionable.

Daily examination is a wise precaution for the first week, since excessive inflammatory swelling and a tendency to displacement are frequent accompaniments of these injuries. The splints may be removed in four weeks. Extreme overriding may require the adjustment of continued extension. In cases kept in bed this may be effected by a weight and pulley; in walking cases by elastic bands attached to a splint prolonged beyond the hand. Shortening is not a matter of much moment except when due to such overriding as may impair rotary motion by encroaching upon the interosseous space.

Fig. 217.



Scott's splint for extension in fracture of forearm. (Stimson.)

Fracture of Shaft of Ulna.—If the radius is neither broken nor dislocated, shortening is not possible in fracture of the ulnar shaft. Lateral or angular displacement is readily discovered because of the subcutaneous position of the ulna. Alternating pressure above and below the supposed fracture, or grasping the two portions of bone firmly with the fingers and endeavoring to move them in opposite directions will usually prove or disprove the existence of crepitus and mobility. If the tip of the olecranon be quickly tapped with the fingers of one hand while the lower end of the normal ulna is grasped with the fingers of the other hand, the transmission of the vibration along the entire length of the bone will be readily felt. In a broken bone this transmission will be much less perfect. Attempts to twist the arm may develop crepitus otherwise not easily elicited. Forward dislocation of the head of the radius is said to be a not unusual complication of ulnar fractures, and may be overlooked.

Moulding by digital pressure is the only efficient agent for correcting displacement, and must be so exerted as to avert infringement of the interosseous space by angular deviation of the fragments. The same dressing as that described for fracture of the shafts of both bones is applicable, though complete supination is not demanded as in the former case. The prone position is not allowable, but the semi-supine will often do as well as the supine. In most cases the elbow joint had better be controlled. The circular gypsum dressing is often very convenient and efficient. If

the posterior gutter of felt or metal is used, it is important that it should support the ulna along its entire shaft as well as at its ends, lest sagging occur at the seat of fracture. The splints should be kept on about three weeks.

FRACTURES OF THE SHAFT OF THE RADIUS.—The function of the radius as the movable segment of the forearm, to which the hand is attached, gives great importance to this fracture and warrants a guarded prognosis. Displacement is liable to be angular, forward and toward the ulna, and the supinating muscles have a tendency to supinate fully the upper fragment if the solution of continuity occurs above the round pronator's insertion; while the hand and lower fragment tend to take the prone position. Marked displacement of the lower fragment at its upper end toward the ulna alters the plane of the lower articular face of the bone and gives the hand an abnormal deviation toward the radial side. Power of voluntary supination and pronation is gone, and the hand and forearm when grasped seem to be loose and flaccid. Overlapping is impossible unless the splint-like ulna be broken or dislocated.

FIG. 218.

Fracture of shaft of radius. (HAMILTON.)

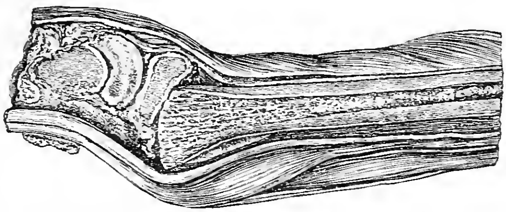
The diagnosis is established by mobility, crepitus, and occurrence of the deformities just mentioned. Absence of rotation of the radial head when the hand is grasped and twisted backward and forward is a certain indication of fracture. In making this examination the surgeon should grasp the elbow and place his thumb on the head of the radius as it lies just below the outer condyle of the humerus. A rubbing sensation similar to fracture-crepitus is here quite often developed when no fracture exists. This is due to friction of the joint surfaces or to inflammatory exudation among the muscles and tendons. The treatment should be the same as in fracture of both bones, with the limb kept in the supine posture. This is especially demanded in fractures of the upper part of the shaft. If the hand is much displaced extension of the ulnar side may be valuable in obtaining and maintaining correct apposition. In accompanying dislocation of the lower end of the ulna extension by some such device as that figured under fracture of both bones may be necessary. Motion of the hand and elbow had better be controlled in most cases. At the end of three weeks the splints may be discontinued and a simple bandage used.

Fractures near the Wrist-joint.

FRACTURE OF THE LOWER END OF THE RADIUS.—This exceedingly common fracture was long misunderstood and is still very often improperly treated. It is frequently designated by the name of one or other of those writers who have discussed it, but I shall not mention the names, since such nomenclature serves to confuse the student and to perpetuate erroneous teaching. The usual fracture line is situated from one-third to three-quarters of an inch above the articular surface of the bone; and is generally more or less transverse in direction, though some tendency to lateral or antero-posterior obliquity is not infrequent.

Displacement of the lower fragment backward upon the lower end of the upper fragment is the ordinary deformity and is due to the fracturing force, not to muscular contraction. Some impaction is quite frequent from driving of the dorsal wall of the upper into the cancellated struc-

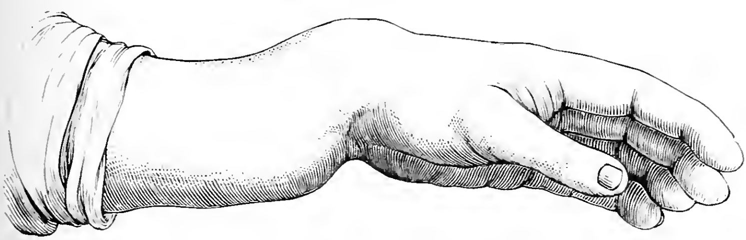
FIG. 219.



Vertical section showing epiphyseal separation and backward displacement of lower end of radius. (BRYANT.)

ture of the lower fragment; and actual loss of substance from crushing the bony tissue is not unusual. At times there is little displacement; at others it occurs at the radial but not at the ulnar side of the lower fragment, which is tilted obliquely backward. The styloid process of the

FIG. 220.



Deformity in fracture of lower end of radius (diagrammatic). (LEVIS.)

radius is carried upward and backward by this displacement; and, therefore, in fracture of the lower end of the radius the radial styloid process is often on the same level as, or even higher than, the ulnar styloid process.

FIG. 221.

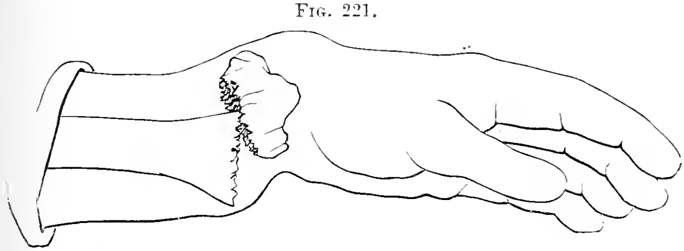
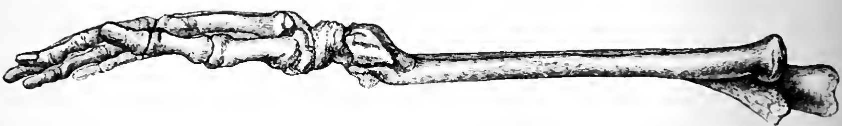


Diagram of displacement in fracture of lower end of radius. (LEVIS.)

This angular displacement tends to throw the articular surface with the attached carpus upward, backward, and to the radial side. Hence occur the peculiar deviation of the hand and the under prominence of the lower end of the ulna, which gives such a characteristic appearance to the limb

after this injury. The hand is, as it were, carried away from the ulna by the force which breaks the radius and displaces the lower fragment. Sometimes the ulna is actually forced through the integument by the violence with which the hand is forced away from it, on account of the forcible shortening of the radius. Such a wound, however, does not necessarily create an open or compound fracture, for the wound does not always communicate with the fracture. Prepared specimens of united fractures give perhaps a false notion of the amount of impaction originally existing, because the formation of callus beneath the stripped-up periosteum or the dorsal surface is misleading.

FIG. 222.

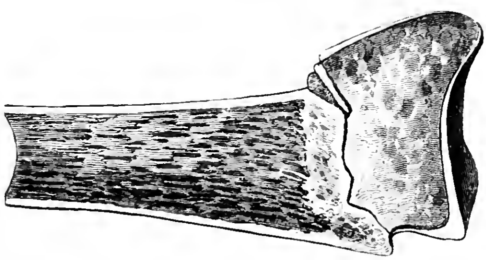


An old fracture of lower end of radius united with deformity uncorrected. (ERICHSEN.)

The wrist-joint is not involved unless, as often happens, longitudinal lines of comminution divide the lower fragment or base of the bone into more than one piece. Fracture of the lower end of the ulna, or of its styloid process alone, and rupture of the radio-ulnar ligaments and cartilaginous attachments are occasional associated lesions; but, as a rule, fracture of the base of the radius is uncomplicated except by comminution.

In young persons epiphyseal separation, with a causation and deformity similar to that which pertains to fracture, may occur. The treatment of the two injuries is identical.

FIG. 223.



Vertical section of fracture of lower end of radius, showing usual backward displacement. (R. W. SMITH.)

The fracture just described is practically the only one that occurs at the lower extremity of the radius; though in rare cases irregular fracture lines splitting off the radial or ulnar side of the base by lines more or less vertical running into the joint have been described. Displacement forward of the lower fragment, that is, displacement toward the palmar surface, has been described as occurring after transverse fracture above the joint when the force has been received upon the back instead of, as usually, upon the palm of the hand.

The uniformity of the lesion produced when the radius is broken at the wrist shows that the mechanical conditions causing the fracture are usually

the same. When a man falls either forward or backward his arms are extended to protect himself, and the violence consequently is received on the palms of the outstretched but not completely pronated hands. The force is thence transmitted to the radius which is concave on its palmar surface. Fracture occurs across this concave portion of the bone: 1. Because the arch has strain brought upon it, and is by nature a weak part of the bone. 2. Because there is a cross-breaking force exerted here, when the hand is violently extended backward, by the ligaments on the palmar aspect of the joint; the end of the bone is thus torn off. 3. Because penetration and crushing of the cancellated osseous tissue is caused by the lower end of the bone being driven against the shaft.

Stimson thinks that the first theory is a better explanation of the usual mechanism of the fracture than the others, though he admits that the lesion may be caused in all three ways. I am inclined to believe in the truth of his argument.

The symptoms of the fracture are so marked that, in a typical case, error in diagnosis is impossible, if it is only recollected that dislocation of the radio-carpal joint is exceedingly rare. The deformity of the fracture so resembles that of backward dislocation of the carpus that the fracture has at times been called a dislocation. This error has received apparent confirmation from the fact that after the displaced lower fragment is pushed into position, there is little tendency except in comminuted fractures, to reproduction of the deformity. The transverse character of the break, and the absence of muscular displacing causes render secondary displacement almost impossible unless the wrist is subjected to considerable violence. Let the student recollect that injuries of the wrist suggesting dislocation of the carpus are nearly always fractures of the lower extremity of the radius.

Symptoms.—The characteristic distortion has given the name "silver fork fracture" to the injury. The hand is apt to be held semi-prone. Voluntary movements of the wrist are painful, and hence are lost, though finger motions are but slightly impaired. On the radial side of the back of the wrist there is a prominence, the upper margin of which can sometimes be felt as a sharp bony edge. The radial extensor tendons may sometimes be felt stretched across the space between the shaft and the upper portion of this prominence, which is, of course, the displaced lower fragment. Forced flexion of the hand will render these tendons more tense and therefore more easily perceived. On the palmar surface of the wrist there is a transverse furrow behind the ball of the thumb, and behind that a prominence due to the lower end of the upper fragment and the inflammatory effusion which takes place into the sheaths and tendons of the flexor mass of muscles. The hand usually deviates somewhat to the radial side, the ulna is unduly prominent on the posterior and ulnar aspect of the wrist, and the styloid process of the radius is on a level or even higher than that of the ulna. Mobility and crepitus are often absent because of impaction; though both may be developed by strong pressure upon the dorsal prominence, which at the same time forces the displaced portion of the radius into position with a sensation of snapping or grating. In comminuted or unimpacted cases motion and crepitus are often easily detected. Motion at the wrist-joint or in the carpal articulations may be mistaken for fracture mobility. When no displacement occurs there may be no distinctive symptoms except a tender spot upon the bone, which cannot be attributed to arthritis as it is a little above the known location of the joint.

Diagnosis.—The diagnosis must be made between sprain of the wrist, fracture of the lower end of the radius, and dislocation of the carpus. If no deformity such as described above exists, it nevertheless may be a fracture with little laceration of the periosteum and no appreciable displacement. The diagnosis then hangs upon the character of the vulnerating force, the age of the patient, and the position of the tenderness on pressure. If the patient is beyond middle age, has fallen heavily on his palm and complains of localized tenderness about half an inch above the joint, fracture is the probable lesion. If the point of tenderness is over the wrist-joint, if the patient is young, or if the fall was a slight one, a sprain with subsequent arthritis is the most likely injury. When the usual displacement backward of the lower fragment has taken place, an error is impossible after a careful examination, though it is true that the swelling of severe sprain does sometimes simulate the deformity of fracture.

Backward dislocation of the carpus is the only luxation resembling fracture, and any dislocation about the wrist is exceeding rare. Backward dislocation would show no change in the relative position of the styloid processes to each other, would give a smooth, laterally convex upper border to the dorsal prominence, and would be reduced with a smooth snap rather than with a rough grating. Deformity would probably be more easily reproduced than in the usual non-comminuted fracture. Dislocation of the radio-ulnar joint would give a very different distortion from that of fracture of the base of the radius.

In a person of fifteen to twenty years, epiphyseal separation is to be expected rather than fracture. The exact diagnosis is, however, unimportant, for the treatment is identical with that of fracture. Interference with the future growth of the bone may perhaps follow epiphyseal separation.

Treatment.—The essential point in the treatment of this fracture is early and complete replacement of the lower fragment. The protracted convalescence and frequent stiffness of the wrist and fingers seen after this injury are due to imperfect reduction of the fracture and the confinement of the fingers during the use of the fracture dressing. When there is neither comminution nor loss of tissue by crushing, the fracture can usually be cured in three to five weeks with little or no deformity, and without stiffness of the fingers. When comminution and crushing exist, cure without impairment of motion, though perhaps with more or less persistent deformity, is nearly always possible, and in the same time. When I say "cured," I do not mean that every vestige of swelling and of osseous thickening disappears so soon, but that the limb is capable of performing its ordinary functions. Old and rheumatic patients may perhaps exhibit a greater tendency than others to rigidity of the joints; but I cannot insist too strongly on my belief that stiff fingers are usually an indication of imperfect reduction of the fragments, which by their projection interfere with the extensor and flexor tendons and cause adhesive inflammation. No apparatus should be applied that restricts, at any period of the treatment, full and free motion of the fingers. In uncomplicated cases the splint need not be worn more than about ten days; provided that the patient is sufficiently intelligent to avoid submitting the arm to unexpected strains and blows. This is because of the slight tendency to reproduction of deformity in the properly reduced fracture. In careless patients, and in comminuted or otherwise complicated fracture, support by the splint should be continued for three weeks. Uncompli-

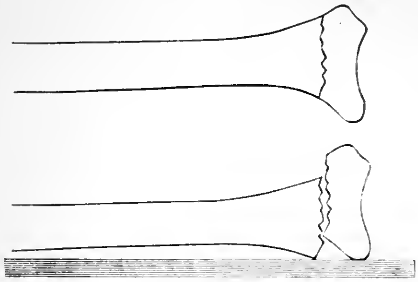
cated cases in intelligent persons may be treated without any splint whatever. A band of adhesive plaster, or a roller bandage applied firmly around the wrist at the seat of injury, is all that is necessary after perfect reduction has been accomplished. Passive motion is probably never necessary if the fracture is properly replaced, and the play of the fingers not restricted during the use of the splint.

Reduction is always painful, but is usually so quickly accomplished that an anæsthetic is seldom needed. Ether or nitrous oxide should be employed, however, if there is likelihood of the pain preventing perfect coaptation of the parts. The surgeon must apply force directly to the fragments. Let him put the patient's hand in the prone position, grasp the middle of the forearm with one hand, and take hold of the patient's palm with the other hand in such a manner that his thumb can make strong pressure upon the apex of the dorsal prominence. By making traction on the hand of the patient and then suddenly flexing the patient's wrist, while at the same time he presses with his thumb strongly upon the projection at the back of the wrist, he can nearly always force the lower fragment into its proper position without difficulty. A repetition of this manœuvre is sometimes requisite before accurate replacement is obtained. The grating produced as the fragment, which may have been impacted, is driven into its normal position, can at times be distinctly heard by bystanders. The limb at once assumes its normal contour. The disappearance of the bony edge or shoulder previously perceptible to the touch where the upper margin of the lower fragment was elevated above the level of the shaft of the radius, is an indication that reduction of the backward displacement has been accomplished. Still further manipulation may occasionally be necessary to reconstruct the normal outline of the radius, which has at the wrist, it will be remembered, a concave palmar surface.

If great comminution or crushing has been incidental to the fracture, *perfect* restoration of shape may be impossible, although the deformity can be greatly diminished. In such cases, also, retention of the fragments in good position may be somewhat difficult. Firm impaction or entanglement of the fragments in the tendons or dorsal periosteal bands may require that the hand and attached lower fragment be first bent strongly backward, in order to release the interlocking before making traction, flexion, and pressure. This preliminary measure is not often necessary. After reduction has been accomplished any form of dressing is allowable provided it immobilizes the limb, does not tend to obliterate the normal curve of the palmar face of the radius, and permits the patient to move his fingers. It was formerly thought that splints deflecting the hand to the ulnar side exerted traction on the radial side of the wrist, and were therefore indicated. This is incorrect teaching. Such splints are unnecessary, as the deflection only causes the carpus to roll in the articular surface of the radius. The hand should be placed in the prone or semi-prone position, and a single splint, extending from below the elbow-joint to the middle of the metacarpus, applied either to the dorsal or palmar aspect of the forearm. It is essential that the palmar splint, if it be chosen, should be convex on its upper surface at its carpal extremity, so as to preserve the integrity of the radial concavity and not to make the palmar surface of the radius flat, by forcing upward the lower fragment which has just been pushed down into proper position by the surgeon's manipulations. This convexity may be obtained by using the moulded splint of Levis, or a splint of wood with a hard convex pad to fit into the palmar concavity

of the radius. It should be seen that the pad properly fits. The surgeon can readily make a pad out of soft wood and fasten it with screws to a straight splint. No dorsal splint is needed with either of these splints.

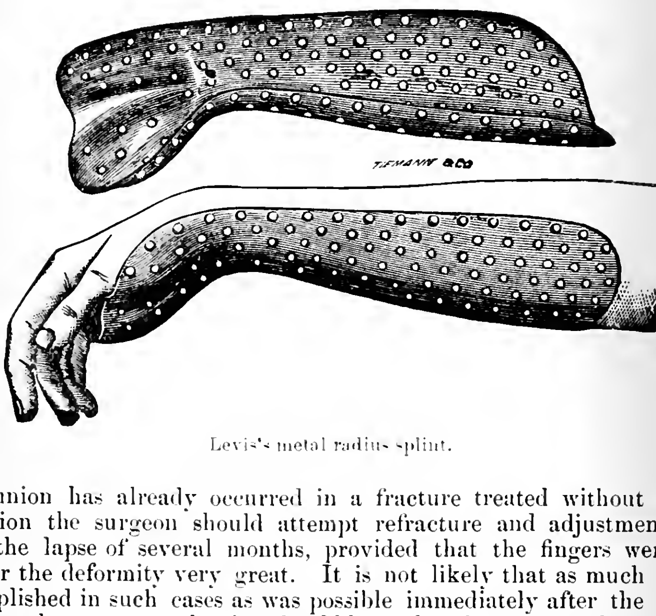
FIG. 224.



Showing injurious effect of straight palmar splint in fracture of lower end of radius.

If it is inconvenient to obtain a proper form of curved palmar splint a flat splint may be applied to the dorsal surface of the radius, which presents no curve but is straight. Bond's splint, so frequently employed, is dangerous to the future contour and utility of the limb, and should never be used. After the splint has been employed for from a week to ten days, varying, as above stated, with the kind of fracture and disposition of the patient, it is well to substitute it by a strip of adhesive plaster, two inches wide, applied circularly around the wrist so as to give moderate support to the partially consolidated fracture.

FIG. 225.



Levis's metal radius splint.

If union has already occurred in a fracture treated without proper reduction the surgeon should attempt refracture and adjustment even after the lapse of several months, provided that the fingers were very rigid or the deformity very great. It is not likely that as much can be accomplished in such cases as was possible immediately after the receipt of injury, but proper reduction should be undertaken even at late periods.

Good use of the hand is often obtained finally even where there exists a considerable degree of deformity. Rigidity of the fingers if permitted to occur remains, however, for many months. Refracture for correction of deformity is readily accomplished if the surgeon will bend the bone across his knee. Osteotomy need not be undertaken.

Other Fractures near the Wrist-joint.—Fracture of the styloid process of either the ulna or radius occurs, though rarely. The diagnosis is not difficult. All that is needed for treatment is such a dorsal or palmar splint as will prevent motion at the wrist and fix the hand in a deflected position; toward the ulnar side in fracture of the ulnar styloid process, toward the radial side in fracture of the styloid process of the radius. A circular gypsum dressing will probably best meet the indications. Fracture of the lower end of the radius, with displacement forward—that is, toward the palmar surface has been mentioned as a rare form of injury, due to receipt of violence on the back of the hand. It should be treated with the same form of splints as is the common fracture at the lower end of the bone; but of course the primary reduction is to be made by pressure in an opposite direction.

Fracture of both the radius and ulna just above the joint occasionally happens. It, in appearance, much resembles backward luxation of the carpus, but is distinguished therefrom by crepitus, mobility and the preservation of the normal relation of the styloid processes to the bony landmarks of the hand. The treatment is similar to that of fracture of the lower end of the radius, but this injury must not be treated without a splint, as some forms of the latter injury may be. In instances, however, where the line of fracture is some distance above the joint, the lesion partakes of the characteristics of fracture of the shafts of the two bones and should be treated as such, in order to preclude the possibility of callus interfering with future supination and pronation.

Fractures of the Carpus, Metacarpus, and Phalanges.

Fractures of the Carpus.—Uncomplicated fractures of the carpal bones are rare, though it is probable that they occur at times in connection with radial fractures and other injuries, but are unrecognized. The diagnosis must be made by the presence of crepitus or deformity. Preternatural mobility, unless very marked, could be determined only with difficulty in a region containing so many movable bony components. Ankylosis of some of the intracarpal articulations seems a probable consequence of carpal fractures, but it would cause little disability. Crushing injuries, due to direct violence, and causing extensive lesions of the soft parts, quite often produce open and comminuted carpal fractures. Such cases, however, do not derive their importance from the broken carpal bones.

Fractures of the Metacarpus.—The so-called metacarpal bone of the thumb is not included in this discussion because it is anatomically a phalanx. Its fractures are included, therefore, under fractures of the phalanges. Metacarpal fractures are generally caused by direct violence received on the dorsal or palmar aspect of the hand; or by force so applied to the anterior extremity of one of the bones as to exaggerate its normal curve. To the latter mechanism is due the occasional breaking of a metacarpal bone when a man strikes a violent blow with his fist, receiving, of course, the impact on his knuckles. The common displacement is

angular with the projection of the angle toward the back of the hand and the anterior end, or head, of the bone prominent in the palm. Lateral overriding is not an unusual feature. The single epiphysis of the bone which is at the anterior extremity, may be torn off in patients not over twenty years of age, and give the symptoms of true fracture.

When firm pressure is made in the palm, pain, yielding, and the occurrence of a prominence on the back of the hand will, as a rule, be developed in those cases of metacarpal fracture that are not at once clearly demonstrated by the ordinary symptoms. A sharp pain at the seat of fracture can often be produced by taking hold of the finger, attached to the metacarpal bone supposed to be injured, and suddenly pushing it toward the wrist. Actual shortening of the broken bone is often quite as characteristic as motion and crepitus. Union takes place in about three weeks.

Traction of the finger and pressure upon the dorsal prominence are sufficient to overcome the displacement in the majority of cases. If no tendency to recurrence of deformity exists, a layer of cotton in the palm and another on the back of the hand, held in position by a circular bandage, constitute an efficient retentive apparatus, though care must be observed lest lateral displacement be caused by the bandage. In other cases support to the fragments and the adjoining bones, and prevention of deformity is best obtained by placing a cylinder of wood, a roller bandage, or a spherical object, such as a billiard ball, in the palm, and keeping the flexed fingers closed upon it by strips of adhesive plaster carried from the back of the wrist, over the knuckles, around to the palmar surface of the wrist.

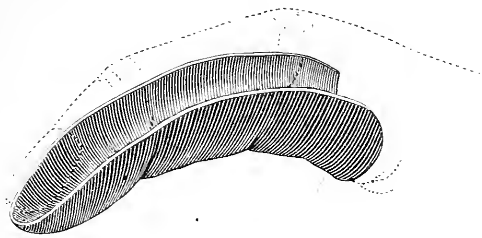
Longitudinal splints applied to the palm or dorsum, or both, and controlling the wrist and fingers, may be preferable in some cases. In other instances short transverse splints placed across the back and front of the hand may be found more efficient in meeting the indications. When the tendency to overlapping is marked, no method is as good as continuous extension. This can be done by the use of adhesive plaster strips applied to the back and front of the finger, and a rubber cord extending from the loop of plaster to a nail or screw in the end of a long palmar splint firmly adjusted to the forearm and hand and extending beyond the finger-tips. This method is identical with that used in fractures of the thigh-bone.

Fractures of the Phalanges.—As these injuries are generally caused by direct violence, they are frequently complicated by comminution, dislocation, and great laceration of the soft parts. The phalanges and the so-called metacarpal bone of the thumb, which, properly considered, is a phalanx, are developed from two ossific centres; one for the shaft and one for the posterior extremity, or base. Epiphyseal fracture is, therefore, a possible lesion in persons not over twenty years of age. The swelling after phalangeal fracture often conceals the deformity to such an extent that mobility and crepitus are the chief diagnostic features. The prognosis is good except when great comminution or the occurrence of suppuration renders necrosis probable. Quite firm union may be expected in about two weeks if the fracture is uncomplicated.

Lateral and rotary deviation is to be corrected with especial care in phalangeal fractures, for a crooked finger is not only unsightly, but may interfere with the manual dexterity of an artisan. Bowing of the middle of the phalanx toward the palm tends to prevent the patient grasping objects firmly and must be avoided. If ankylosis is apprehended the finger should be slightly flexed during treatment, for stiffness in the partially-

bent position is the least inconvenient and least noticeable. A splint of gutta percha, pasteboard, felt, copper, or zinc moulded to the palmar surface of the member and to the finger-tip is a neat and effective fracture apparatus. If the proximal phalanx is the seat of lesion, such a splint should include the palm and wrist. A cylindrical pad in the palm, with the fingers closed over it, and kept so fixed by adhesive plaster, as described under fractures of the metacarpus, is often a good dressing. A

Fig. 226.



Gutta percha splint for finger. (Hamilton.)

straight palmar splint, the circular gypsum dressing, or continued extension by a rubber band may, in certain circumstances, be more advantageous. If necessary, the finger or fingers adjoining the broken one may be used for giving lateral support, or two or three fingers may have to be kept motionless by a wide splint in order to immobilize the injured member.

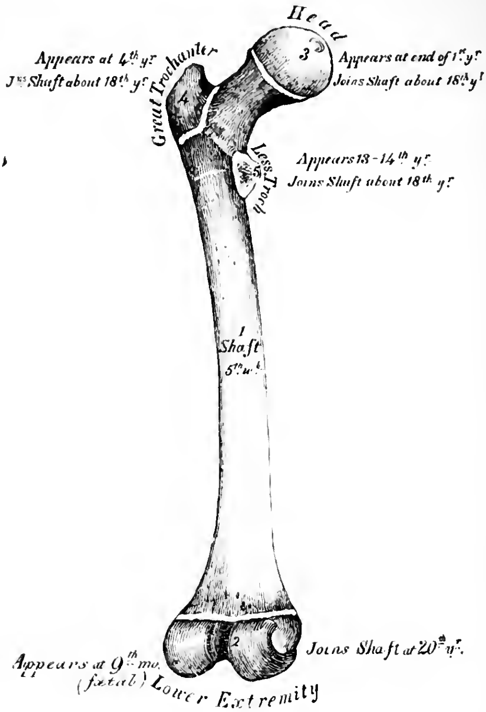
Amputation is frequently demanded in fractures of a complicated character. Conservatism, however, should be the rule, for a portion of a finger or a stiff one is often better than none. Especially is preservation of the smallest apology for a thumb desirable in order that the patient may have something to oppose to the other fingers when grasping objects. While it is true that in certain mechanical operations a deformed or immovable finger may be an annoyance and disability, and while recovery will in many cases be sooner attained by amputation than by conservative attemps; still the latter course is to be advocated in doubtful cases. Unexpectedly good results are often secured, even when joints are involved, and the patient learns to manipulate with the disabled hand, which moreover preserves its complete integrity. The risks of prolonged suppuration and of other secondary troubles which may follow conservatism, are practically annihilated by antiseptic methods. After cure is complete the mechanic can test the utility of the hand for a few months, and then, if the deformed finger is a detriment to bread-winning, it may be removed by amputation with little risk.

Fractures of the Femur.

Fractures at the Upper End of the Femur.—Of these there are fractures of the neck which may involve the greater trochanter or head, fractures detaching the greater trochanter, and fracture through the base of the trochanter and upper end of the shaft. The first variety is common. The others are exceedingly rare, and may be dismissed with a few words at this time.

Fracture of the trochanter is the result of direct violence, and is to be diagnosticated by displacement of the fragment, character of the injury, local pain, and absence of the symptoms found with fracture of the neck of the femur. Epiphyseal detachment may be suspected in such cases if the patient is not over eighteen years of age. A bandage or strips of adhesive plaster around the hips, with an appropriate compress, would seem

Fig. 227.



Posterior surface of femur showing epiphyses. The three upper epiphyses unite about the eighteenth year; the lower one about the twentieth year. (Gray.)

to be the proper method of treatment. Hooks similar to those employed for fracture of the patella would not be improper if the displacement was very marked.

Fracture more or less transverse through the base of the trochanter and upper part of the shaft is said to occur. Its diagnosis is uncertain, but its treatment is the same as for fractures of the neck.

Fractures of the femoral neck are very common and very important surgical lesions. The classification of Stimson seems to be the best. He divides them into fractures of the small part of the neck, and fractures at the base of the neck. The former is identical with the class often called intracapsular fractures, and includes the rare condition, separation of the epiphysis of the head; the latter includes both the so-called extracapsular fractures and those which are partially intracapsular. The reasons for rejecting the old classification are: that the neck is entirely covered by the capsular ligaments in front and below, while behind and

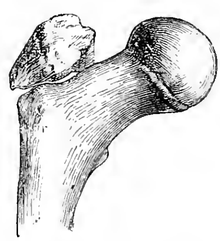
above only about three-fourths of its length is so covered, and that the extent of capsular envelopment varies in different persons; that the synovial membrane does not extend as far out upon the neck as does the the capsule, hence a part of the neck is *extra*-articular though really *intra*-capsular; that the line of fracture is frequently not confined to either the intra- or extra-capsular portion of bone, and that the clinical diagnosis between intra- and extra-capsular lines is often impossible; as can readily be understood by what has preceded. Even at the autopsy the fact of a given fracture being intra-capsular, or rather intra-articular, for it is the relation to the joint that is important, can only be known by accurate examination of the synovial membrane. This is further complicated by the fact that, after fracture, the outer portion of the cavity of the joint may, it is said, be obliterated by adhesion of the capsule to the periosteum.

Fig. 228.

Fracture of epiphysis of great trochanter and fracture of condyles. (Agnew.)

Impaction and fixation of fragments at the first receipt of injury is very frequent in fractures at the base of the neck, and not infrequent in those of the small part of the neck. Attempts at walking, improper surgical manipulation, and other secondary violence often cause undesirable separation of the interlocked fragments. Cervical fractures of the femur are often due to slight injuries, as a twist from catching the foot in a fold of carpet, missteps, and insignificant falls on the knee, buttocks, and side of thigh. It is possible that in certain positions muscular efforts to avoid falling may be a factor in causing the fracture. An important element in their production is weakening of the osseous tissue by senile degeneration which begins at about the fiftieth year of life, and is said to be more marked in women than in men. This degenerative change is the predisposing cause which permits slight injuries to have such a disastrous effect. It is not a relative increase of earthy constituents that renders the bone more friable; but an actual thinning of the wall of the femur, and also an increase in size of the spaces found in the bone for vessels and fat. The radiating and arched lines of compact bone which cross the cancellous portion of the bone, and which are so readily demonstrated by section of the upper end of the femur, are thus absorbed. This rarefaction of osseous tissue, and consequent loss of resisting power to strains, is a much more potent factor in the frequent occurrence of fractures of the femoral neck than the change of angle between the shaft and neck which has been said to occur with advancing age. Fractures from very slight kinds of violence are very apt to be at the small part of the neck. Fractures of the small part, or constriction of the neck of the femur, seldom occur before the age of fifty years. The line, which is apt to be nearly transverse, may be oblique or irregular, and even run upward into the head of the bone. Impaction, with fixation of fragments, and comminution are not unusual features. A portion of the

Fig. 229.



Fracture of epiphysis of great trochanter. (Bryant.)

periosteum may remain untorn, and assist in keeping the fragments in juxtaposition. In other cases not only is the periosteum completely torn and the fragments separated, but the capsule itself rent by the violence and by displacement of the fragments. The displacement is usually of the shaft upward. In impacted fractures some degree of twisting deformity may exist. The shortening of the limb from displacement is apt to increase gradually during the first week, but rarely exceeds one inch, except when, after weeks have elapsed, absorption of the neck has taken place.

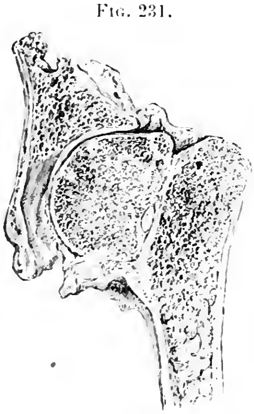
Fig. 230.

Fracture of narrow part of neck. (Hamilton.)

When these fractures are repaired it is usually accomplished by fibrous tissue. Indeed, it has been asserted that bony union never occurs. Such statements are erroneous, though it is true that failure of union or fibrous union is the most common result of the reparative attempts. Bony union does occur, though rarely. The question is of little clinical importance, since a short fibrous bond gives as useful a limb as an osseous one; and union should always be sought by treatment, if the patient's condiition will permit the necessary confinement.

Examination of specimens, with or without a history of fracture, does not throw as much light on the question as would be supposed, because the arthritic changes of old age and interstitial absorption of the neck of

Fig. 231.



Fracture of small part of neck united by bone, fibrous tissue, and cartilage, showing absorption of neck. (Bryant.)

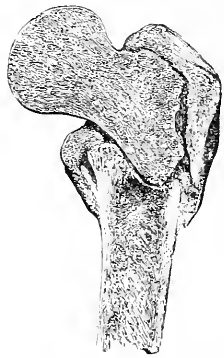
Fig. 232.

Femur of opposite side, showing amount of bone absorbed on injured side. (Bryant.)

the femur which occur subsequent to cervical fractures, obliterate or simulate lines of fracture. Simple contusion of the hip is supposed by some writers to be a cause sufficient to induce in the aged interstitial absorption of the neck of the femur.

The cause of such frequent defective union appears to be want of contact between the fragments, imperfect immobilization, and some constitutional peculiarity. The difficulty of obtaining perfect contact and immobilization when the small upper fragment is so inaccessible and floats in such a cup-like cavity as the acetabulum, will be easily understood. The error of rude manipulation, by which impacted fragments may be separated, is a useful lesson taught by this statement. It would seem that the constitutional tendency, already mentioned as a cause of the extreme fragility of this part of the skeleton in aged persons, would tend to interfere with the occurrence of osseous repair. These reasons for defective union seem to be sufficient without recourse to those often given: namely, deficient blood supply to the upper fragment, and contact of the fractured surfaces with the synovial fluid. These agencies, however, possibly exert some influence.

Fig. 233.



Upper fragment driven into the trochanter fragment. (Gross.)

The symptoms and diagnosis of fractures of the small part of the neck will be discussed with similar topics relative to fractures at the base of the neck. The usual result after fractures of the small part of the femoral neck is disability with eversion, and some shortening of the limb. The patient in some cases can walk without crutch or cane, but such a slight degree of lameness is uncommon. Occasionally, feebleness from pain, confinement, and age, renders the unfortunate patient bedridden.

In fractures at the base of the neck the line of fracture shows a tendency to separate the neck from the shaft in the vicinity of the intertrochanteric line, but may be varied or complicated by lines running downward into the shaft, splitting off the lesser trochanter, extending along the neck toward the head, or involving the upper portion of the great trochanter. Bending the neck backward, with crushing or penetration near the posterior part of the greater trochanter, is said to be a very common form of the injury. Various degrees and forms of penetration and impaction of the cervical into the trochanteric fragment have been described. The trochanteric fragment or shaft is seldom forced into the cancellated structure of the neck. These fractures usually unite by bone, and in six or seven weeks; showing, therefore, much better reparative effort than fractures of the narrow part of the neck.

Symptoms.—The distinctive symptoms of fracture of the neck of the femur are motor disability, eversion, shortening, and crepitation. To these may be added certain incidental symptoms that occasionally assist in the diagnosis.

The limb is usually so helpless that no voluntary effort can lift it from the bed, nor can the weight of the body be borne upon it in the erect position. Sometimes slight elevation of the thigh is possible, especially if the patient can get a purchase on the bed for his heel. In very exceptional cases walking on the injured limb has been possible. Here firm impaction has almost certainly existed. In making a differential diagnosis the helplessness following severe sprain or contusion must not be forgotten.

The posture assumed by the limb is almost pathognomonic. It lies, as the patient rests on his back, upon its outer side with the little toe almost

or quite touching the mattress, and the heel on a level with the space between the inner malleolus and point of the calcaneum of the other foot. A slight degree of flexion and abduction at the hip is quite usual. This eversion is probably, in the main, the result of gravity being unresisted by the normal supporting agencies of the limb rather than due to the action of the external rotators or other muscles. In some cases the eversion is slight, at other times the toes point directly upward, while in rare instances actual *inversion* exists. Angular deformity at the seat of fracture, crushing, impaction, and interlocking of fragments and entanglement in capsular rents have probably an agency in the production of the varying degrees of eversion and inversion. Eversion is the usual position and is very suggestive of fracture, though it has been observed in simple injuries of the hip. The normal position of the limb, indeed, when the recumbent posture on the back is assumed, is eversion, and especially so when the knee is flexed even slightly. It is well to compare the injured limb with the uninjured one to determine whether eversion is apparent or real, whether the extent of possible eversion at the surgeon's hands is greater or less on the injured side, and whether the supposed fracture interferes with or increases *inward* rotation, such as is possible in the sound limb. Inversion has been described as occurring in some cases only after the lapse of a day or two from the time of injury. Violent manipulation to determine these points is not justifiable, since other symptoms are available for diagnostic purposes.

Shortening occurs in cervical fractures of the femur from overriding, and from alteration of the angle between the shaft and the neck. It varies from a mere fraction of an inch, to two, three or even four inches. It may exist to its greatest degree immediately after the injury, or may gradually increase with the lapse of a few days. It has been noticed to occur suddenly, when little or no alteration in length was apparent at the first examination.

Great shortening ($1\frac{1}{2}$ to 3 inches) occurring immediately is rather indicative of fracture at the base of the neck, while slight immediate shortening followed by increased shortening is more characteristic of fracture at the small part of the neck.

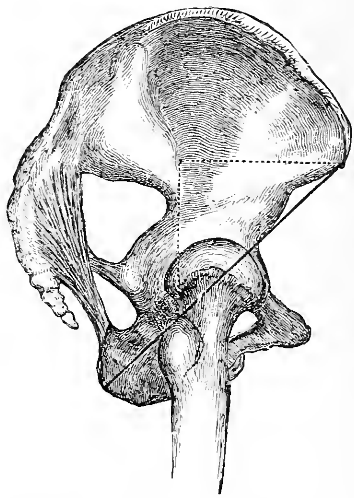
The now well-established fact that femurs and tibias are often of unequal length in persons who have never sustained injuries to the bones of either limb greatly lessens the diagnostic importance of shortening. If a limb which is a half-inch or one inch longer than its fellow is fractured, and a half-inch or one inch shortening occurs, the two limbs when examined by the surgeon will measure exactly the same, and no evidence will be derivable from such attempts at estimation of shortening. If the shorter limb is subjected to traumatism, shortening may seem to exist when such is not the case; or the traumatic diminution in length which actually exists will appear to be greater than it is. Fortunately the normal difference of length rarely exceeds a quarter- or half-inch.

The most practical method of measuring the length of the limbs is to carry a tape measure from the lower edge of each anterior superior spine of the ilium to the tip of the corresponding internal malleolus. It is well, perhaps, to verify the differential measurement by placing the upper end of the tape at the lower margin of the umbilicus, and holding it there while the lower end is successively carried to the two internal malleoli. During the measuring the pelvis must be horizontal—that is, at a right angle with the median line of the body—and the two limbs in the same condition of abduction and extension. The difficulty of obtaining exactly

the same point of measurement on the two sides, because of the mobility of the skin and the want of definite outline in the prominences, together with the fallacy above mentioned, have made me place little confidence in the accurate estimation of fracture shortening.

The determination of the relative position of the two greater trochanters by means of Nélaton's line or Bryant's rectangle is of great value in proving elevation or absence of elevation of the trochanter on the injured side. The method is useful in supposed dislocations as well as fractures, but will be discussed here. Nélaton's test line is applied by carrying a string from the tip of the anterior superior spine of the ilium to the tip of the tuberosity of the ischium. The line so indicated touches the upper border of the greater trochanter, and this relation is not disturbed by flexion and extension of the limb. Displacement of the trochanter upward, from shortening due to cervical fracture, and displacement downward or upward, as a result of dislocation, are indicated by comparing the two hips. The two limbs must be examined when neither abducted nor adducted, since in normal limbs the former position brings the trochanter above the line and the latter below it. Bryant's rectangle consists of two lines drawn while the patient lies upon his back. A vertical line is dropped from the anterior superior spine of the ilium to the bed; toward this line, at a right angle to it, a second line is drawn from the upper border of the trochanter. The last drawn line determines the fact and degree of elevation of the trochanter as compared with the sound side. The fallacy due to abduction or adduction must be remembered here, as in using Nélaton's line.

Fig. 234.



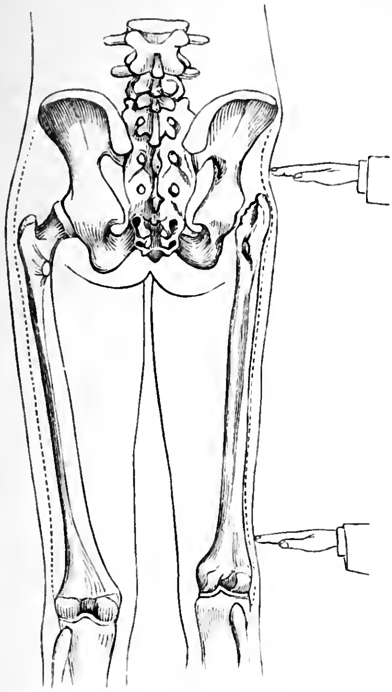
Nélaton's line, dark. Bryant's rectangle, dotted. (Erichsen.)

Stimson uses Bryant's method by placing a small stick or pencil vertically against the pelvis in a line with the process and tuberosity, and measuring from it to the trochanter. Morris estimates changes in distance between the joint and the trochanter by measuring from the outer surface of the trochanter on each side to the median line of the body. This is readily done by means of a graduated rod placed across the pelvis at the level of the two anterior superior lines of the ilium, with its centre over the linea alba, and having upon each end a sliding vertical bar, which can be moved till it just touches the outside of the corresponding trochanter. These are the simplest and most available plans for determining shortening of the neck or displacement of the trochanter. More complicated geometrical methods introduce more sources of possible error.

Allis has called attention to relaxation of the fascia lata between the iliac crest and trochanter, and above the outer condyle of the femur in fractures accompanied by shortening. Cleeman has directed the profession to observe a wrinkle in the skin over the ligament of the patella, which will be obliterated when the shortening is corrected by extension.

If shortening has been detected, its correction may be attempted for diagnostic and therapeutic purposes by gentle traction and slight internal rotation. Marked rotary movements, however, and absence of support to the limb are liable to cause separation of fragments which may be impacted, and should therefore be avoided. The shortening corrected by traction will usually recur when the traction is intermitted, and thus confirm the diagnosis of fracture.

Fig. 235.



Allis's method of testing relation of fascia lata.

Crepitation is a symptom of cervical fractures of great diagnostic value when elicited, but is often unobtainable. It should seldom be sought for with avidity because of the risk of separating impacted fragments. Pressure behind the trochanter or traction, with or without rotation, will often make it evident; but impaction, great splintering, wide separation of the fractured surfaces, or the impossibility of keeping the small upper fragment steady in the acetabulum, often prevents its production. Cases showing from other symptoms undoubted evidence of fracture should not be submitted to persistent manipulation for the production of crepitus. In obscure cases its development will not usually afford evidence of sufficient value to warrant the risk of detaching impacted fragments. Rubbing of the outer fragment or of a dislocated head upon the ilium sometimes simulates crepitus between two broken surfaces. The character of the grating is softer than in fracture crepitus. Crepitus is more frequently detected with ease in fracture of the base of the neck than in those of the constriction of the neck, especially if the fracture line runs into the trochanter.

The other symptoms liable to be found in cervical fractures are pain referred to the trochanter, groin, or thigh, tenderness on pressure in the groin outside the femoral vessels, swelling or diminished depressibility at the upper part of thigh, ecchymosis appearing only after two or three days have elapsed, spasm of muscles, flattening in the trochanteric region, or enlargement of the trochanter due to splitting or comminution. The outer surface of the trochanter may be further than normal from the middle line of the body, nearer to it, or may present no change in this respect, according as angular deformity, crushing, and separation exist alone or are combined. Morris's method of investigating this symptom has been discussed.

It is evident that, if the normal limb is rotated, the trochanter must move in the arc of a circle whose radius is the distance between the articular surface of the head and the outer surface of the trochanter;

but, when the neck is broken and unimpacted, such rotation will be in the arc of a circle whose radius is the distance from the line of fracture to the trochanteric surface. The second radius will be shorter, and hence the arc of rotation traversed by the trochanter more curved. Such change may be estimated by placing the hand on the outside of the trochanter while an assistant rotates the limb. This test has often been recommended as worthy of diagnostic credence, but it has at my hands been of little service. If thickening of the soft parts and a large amount of callus is detected in the groin, or about the trochanter at the end of one or two weeks, fracture of the base of the neck is of course the probable lesion.

DIAGNOSIS.—The diagnosis that fracture of the neck of the femur exists can usually be made with comparative ease, but whether the lesion is at the constriction or at the base of the neck is a problem much more difficult to solve. It is not a question worth attempting to answer, except in those cases where it is almost self-evident. The treatment of both injuries is the same, the elaborate tables of supposed diagnostic differences between fractures of the constriction and of the base have been proved unreliable, and the endeavor to make an accurate diagnosis is fraught with great danger to the future usefulness of the limb by reason of breaking up impaction and severing untorn periosteal attachments. When there is doubt as to the kind of fracture, or as to whether fracture, contusion, or sprain exists, always treat the lesion as fracture of the base of the neck, and the result will clear up the doubts in the course of a few weeks.

The symptoms which have just been discussed at length will, when taken in connection with the history of a fall and the non-existence of any former arthritis, fracture, or other pathological conditions, seldom fail to indicate that fracture of some portion of the neck has occurred.

The differential diagnosis of fractures of the neck and dislocations of the head of the bone is important. Inversion is so rare in fracture that its existence should at once suggest posterior dislocation. Fracture with inversion would not show a flexed, adducted, and such a fixed hip as the posterior luxations; nor would the presence of the head of the bone over the iliac dorsum or sciatic notch, and its absence from the acetabular region be demonstrable. In fracture with inversion, traction may convert the inversion into eversion and correct the shortening, but not so in dislocation. The anterior dislocations are rare injuries; present flattening of the trochanteric region, abduction, and flexion of the hip, and the unusual fulness or prominence at the abnormal site of the head of the bone. The pubic dislocation is accompanied by shortening, the thyroid not by shortening but by apparent lengthening. In dislocation there is a marked limitation of passive motion, and the limit of possible mobility is reached by a sort of sudden stopping or check felt by the surgeon's hands. In a normal femur the inner condyle and the head of the bone always have the same direction: therefore, the position of the head can be determined in dislocations by observing the direction of the inner condyle. This is not true of fractures of the femur. If there is anterior spinal curvature the hip may be somewhat flexed, and still appear extended. This possible source of error is eliminated by placing the man on his back and flexing the opposite thigh completely on the abdomen, when the second thigh will be raised from the bed, if it be in a state of flexion concealed by the spinal curve.

Prognosis.—Patients with fractures of the femoral neck have died not infrequently from rapid debility, severe arthritis, or other inflammation about the injury, or hypostatic pneumonia. Especially has this been the case in the aged. The unfortunate tendency was possibly dependent in some measure upon fat embolism, but more probably upon the rigid confinement to bed with cumbersome and uncomfortable fracture dressings, which used to be enforced for long periods. Our present methods of treatment with continuous traction and less absolute immobility in bed seem to permit a much better prognosis. The unfavorable outlook so often spoken of in hip fractures is possibly scarcely warranted by our present experience. A certain amount of shortening, eversion, stiffness, and pain often persists even in fractures that have recovered with fibrous or osseous union; but fair, or even very good, use of the limb is not unusual, even in old persons who have apparently or certainly sustained fracture of the constriction of the neck. Even when the fracture remains ununited fair walking is possible, because hypertrophied muscular and tendinous bands may support the pelvis as by a sling attached to the greater trochanter.

Treatment.—In treating fractures of the lower extremity, the firm, level mattress is much more important than in similar lesions of the upper limb. A plain mattress made of hair, and a bed-pan for receiving the dejections, is often preferable to any one of the various forms of fracture bed sold by manufacturers. Careful nursing will prevent injurious movement during the use of the bed-pan. Union is to be sought in all cases of cervical fracture, and its acceptance even in faulty position is more judicious than the production of non-union or violent arthritis in the aged, by reason of vigorous and repeated manipulation, for the purpose of establishing the exact line of fracture or obtaining accurate coaptation. If the existence of dislocation is eliminated, all doubtful cases should be treated as fractures of the base of the neck. Continuous extension or traction, applied by means of a rubber band or weight attached to the leg with adhesive plaster and lateral support to the limb by means of sand-bags, as employed in fractures of the shaft of the femur, is the proper treatment for all fractures of the neck of the bone. The trochanter may be supported by a small pad or sand-bag placed under it. This method of immobilization is to be kept up until consolidation of the fracture takes place. Proof that union will not occur, or satisfactory evidence that the injury was a mere sprain or contusion, indicate its discontinuance. It must also be discontinued if it becomes evident that the patient's life is endangered by the confinement to bed and to one posture. Then, attempts at gaining union may have to be discontinued in order to prevent death from failure of the vital forces. Even when no union occurs, comfort is usually gained by the rest given to the joint and limb for two or three weeks by traction. Union, when it occurs, takes place in from five to six weeks.

The extending force should equal about six to eight pounds, while the counter-extension is to be gained by elevating the foot of the bed about six inches, so as to use the weight of the patient's trunk as a counter-force. The foot should be maintained in a position with the toes pointing upward and a *little outward*, which is the normal posture of the limb when a man lies on his back. Catheterization will be necessary in many patients, and the occurrence of sacral bedsores must be averted by watchfulness and cleanliness.

In order to get more complete immobility at the seat of fracture, the pelvis and both thighs may be encased in gypsum bandages. In addition,

a pad adjusted by a screw, passing through a frame attached to the gypsum dressing, may be arranged to make pressure upon the outside of the trochanter, and thereby hold the fragments in apposition. This is the character of Senn's method.

Gunshot fractures of the femoral neck will require provision for free drainage, and perhaps excision of the head of the bone. Attempts to fasten the capital fragment to the trochanteric one by screws and pegs have been made in the endeavor to avoid non-union, but at the present time such attempts seem scarcely warrantable.

Fractures of the Shaft of the Femur.

Fractures of the shaft of the femur include those occurring in the shaft of the bone anywhere except just above the condyles. The latter, being near the knee-joint and liable to special complications, are discussed under Fractures at the Lower End of the Femur. Transverse fracture of the shaft is not rare in children, but in adults such an occurrence is very unusual. In fractures of the femoral shaft, deformity due to overriding and to angular or rotary displacement is apt to be great. When the fracture is in the upper third, the lower end of the upper fragment is generally tilted outward and forward by the great psoas, iliac, and external rotator muscles of the hip, and the upper end of the lower fragment drawn upward and inward by the flexors of the leg and adductors of the thigh. This special angular distortion is mentioned because it at times compels the adoption of unusual methods of treatment.

Symptoms.—The symptoms indicative of fracture of the femoral shaft are: total loss of voluntary power in the limb, eversion of the foot and leg, and the usual concomitants of fractures, deformity, abnormal mobility, and crepitus. Rotation of the limb is not accompanied by movement of the greater trochanter. The deformity and flexibility of the thigh at the seat of fracture are often entirely sufficient for diagnosis without requiring successive attempts at getting crepitus, which cause pain and may do harm. The shortening, which is chiefly due to the powerful muscles surrounding the broken bone and to the obliquity of the fracture, may be very great, but is overcome partially, if not entirely, during the continuance of strong traction. The estimation of the degree of shortening by measuring is, as has been mentioned under Fractures Near the Hip, subject to fallacies. The symptoms may be a good deal modified by impaction or interlocking of fragments. This condition, however, is unusual.

Union occurs in ordinary cases in about six weeks, after which time the patient may be trusted to use crutches, provided that all possible strains upon the repaired fracture are avoided by suitable supporting dressings, and that no weight is borne on the injured limb in walking. Effusion into the knee-joint often occurs after the fracture, sometimes within a few days, and occasionally it persists for many months. It has been attributed to involvement of the synovial membrane; to invasion of the joint by the blood extravasated at the time of fracture; to coincident sprain of the knee; to interference with venous return, and to the posture and prolonged immobility of treatment. Fractures at the lower third should be expected to present this complication most frequently. It needs, as a rule, no special treatment.

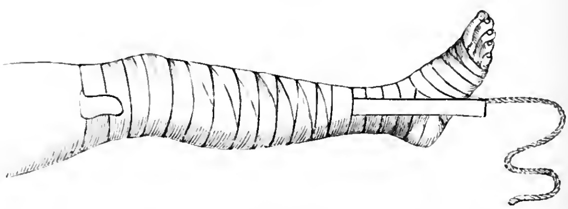
Some permanent shortening is to be expected after every fracture of the femur; but, if union is obtained with the fragments in good line,

without rotary displacement, a shortening of even three-quarters of an inch will cause little limp in the gait. Rigidity of the knee may remain for a long time in rheumatic or aged patients. Open fractures of the femur, especially if also comminuted, are rather dangerous lesions, requiring, in even favorable cases, a protracted convalescence.

In all fractures of the femur, with rare exceptions, permanent horizontal traction, or extension, as it is often called, by means of adhesive plaster and attached weights, is the best method of treatment. Counter-extension is to be obtained by elevating the foot of the bed six inches. This procedure makes the weight of the trunk act as a counter-extending force. Any tendency to lateral mobility or deformity of the fragments may be avoided or corrected by short coaptation splints of wood, metal, or pasteboard, or by long narrow bags, well, but not too tensely, filled with sand and laid closely along the inner and outer sides of the limb. The outer bag should extend from below the sole to within a few inches of the axilla, the inner bag from below the sole to the perineum.

Before the application of the plaster strips the thigh and leg should be shaved. A piece of thin board, three inches wide and five inches long, is

Fig. 236.

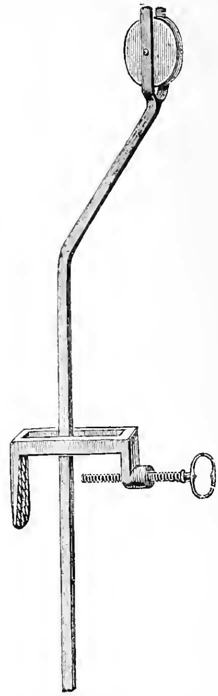


Adhesive plaster and foot-board applied for continuous extension.

fastened lengthwise to the middle of the adhesive side of a strip of rubber adhesive plaster three inches wide and six feet long. This stirrup-like apparatus is then smoothly attached to the limb by applying the plaster up the sides of the leg and thigh to a point just below the seat of fracture. Its adherence to the skin is further assured by applying narrow bands of plaster around the limb and side strips at three points—namely, above the knee, below the knee, and about an inch above the ankle. A bandage is next applied over the foot and malleoli *under* the stirrup, and then carried up the limb *over* the adhesive plaster attachment until it nearly reaches the height of the fracture. The terminal ends of the plaster which project above the last fold of the bandage are now turned over the bandage, so that their adhesive surface becomes external. Around these turned down ends the bandage is applied by a few more folds, until no vestige of the plaster is seen. The attachment of the plaster to the skin should extend above the knee, in order to avoid what might prove injurious traction on its ligaments. The turning over of the ends is additional security against the traction weights causing the adhesive strips to slip on the skin. To the foot-piece a cord about three feet long should be attached so that in the course of an hour, when the plaster has become firmly adherent to the skin, the traction weights may be tied to the apparatus. When it is thought that the plaster will bear the weight without slipping, the surgeon props up the foot of the bed, and, taking hold of the foot and ankle, makes powerful but steady traction to overcome the muscular spasm causing the over-riding and shortening. If there is great shortening,

or if the patient is very muscular, it may be well to obtain relaxation of the muscles by producing a slight degree of general anæsthesia with ether or nitrous oxide. When the deformity has been overcome as much as possible, two or three bricks, or an equivalent weight, are tied to the cord and suspended over a pulley at the foot of the bed. The pulley should be placed high enough to lift the heel a little from the mattress, and in such a position laterally as to keep the axis of the limb correct. The cord should not let the bricks rest on the floor when the patient slides toward the foot of the bed, though it should be long enough to let the patient slide up and down for the distance of a foot or so. There should be no shelf or obstacle above the floor upon which the bricks may catch and suddenly fall off with a jerk. The pulley must have side-pieces or an arch projecting above the groove, that the cord may not be pushed off by persons passing the foot of the bed.

Fig. 237.



Levis's pulley for continuous traction apparatus.

Instead of using the adhesive plaster apparatus a series of straps may be adopted.

The amount of weight for the first three weeks should be from fifteen to twenty-five pounds for an adult, according to the muscular development and tendency to spasm. At the end of that time the amount may be decreased one-half, and be discontinued at about the sixth week. Then a circular gypsum or silicate of sodium dressing is applied from the ankle to the hip, including the pelvis if the fracture is in the upper third, and walking with crutches is permitted. The patient should not bear any of his weight on the foot till the tenth or eleventh week. If the gypsum or silicate dressing is not adopted, sufficient lateral support may be obtained by using coaptation splints of moulded pasteboard, provided that the knee and hip are fixed by them. It is, of course, understood that the patient shall not be permitted to walk even with these dressings, unless the fracture has lost its mobility. Caution must be exerted against subjecting the limb to strains or falls, for rupture of the callus readily occurs, even as late as three or four months after the original injury.

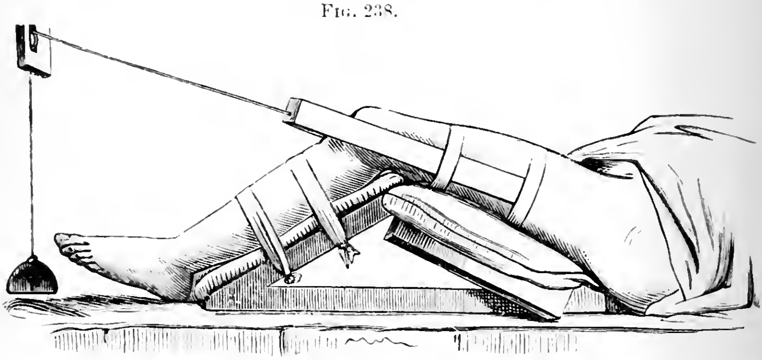
Usually a *slight* amount of padding is required on the bed beneath the popliteal space, because the absolutely straight position of the knee becomes painful unless a little support is given at the point mentioned. If lateral deviation at the site of fracture is not prevented by the sand-bags, or if there is antero-posterior bending, three or four coaptation splints of wood eight to ten inches long may be applied over the bandage and kept in place by a few turns of another bandage. Pasteboard or other plastic material may be moulded to the front or side of the thigh, if the surgeon prefers. Care must be taken that pressure of the heel on the bed does not cause a bedsore. A mass of oakum, wool, or cotton, hollowed out like a bird's nest to receive the heel, or a pad placed beneath the tendon of Achilles so as to lift the heel from the mattress, are the simplest devices for relieving this injurious pressure. The bed-clothes must not rest on the

toes, since their weight will press the foot outward and evert the leg. Any sort of an arched frame, such as can be made from pieces of barrel hoop placed over the foot, will hold the coverings up.

It is also necessary to see that the patient lies flat on his back, for if he turns a little on his side, or if the pelvis sinks into the mattress on one side, while the foot and leg are held motionless by the dressing, rotary deformity will remain when the fracture is united. The foot should be kept very slightly everted, as has been stated under the treatment of Fractures Near the Hip. The patient should not be allowed to sit up in bed nor have a high pillow or bolster, until at least three weeks have elapsed. Then he may be propped up in the half-sitting posture, if it shows no tendency to displace the partially united fracture. The sliding movements up and down in the bed, which are permissible from the beginning, relieve the monotony of confinement very much, and enable the nurse to adjust the bed-pan and keep the patient clean.

When, in fractures of the upper third, there is marked tilting forward of the upper fragment, the straight position just described is not always satisfactory. It may become necessary to elevate the lower fragment, in order to meet the displaced upper fragment and preserve the proper axis of the limb. In order to get proper apposition of the fragments the limb with the traction apparatus attached should be elevated upon an inclined

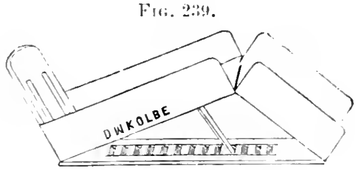
FIG. 238.



Inclined plane and extension apparatus. (AGNEW.)

plane of wood and maintained in that position during the treatment. The weight extension can readily be continued at the same time. Whether the inclined plane is such as will keep the knee straight or flexed is a matter of comparative indifference.

FIG. 239.

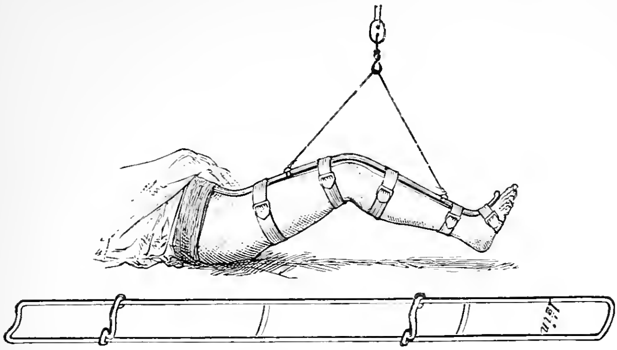


Double inclined plane fracture box.

In treating open fractures with much suppuration a long fracture box or the anterior wire splint of Nathan R. Smith are often convenient. The method of using the anterior splint is shown in the illustration, except

that the pulley should be placed over the middle of the leg so as to obtain extension or traction by the weight of the buttock.

FIG. 240.



Smith's anterior splint.

In infants below five years it is often difficult to prevent soiling of the traction apparatus by the alvine discharges; hence, vertical extension has been employed with good results. This is effected by flexing both hips at a right angle, placing straight splints along the posterior surfaces of the limbs to prevent flexion of the knee, and attaching the feet to a support over the bed. The buttocks thus act as a traction weight and the little patient can be kept clean. If preferred a pulley and a weight of four or five pounds attached to the leg and foot may be used to increase the traction power. When the child is over four or five years of age the ordinary horizontal traction is easily employed. The weight should be about one pound for every year. Union becomes firm in children in about four weeks.

FRACTURES OF THE LOWER END OF THE FEMUR.—These injuries, occuring so near the knee-joint and having a short lower fragment, which may be difficult to control, deserve some special consideration. The line of fracture may be in the shaft just above the condyles, may at the same time run dowward between the condyles, splitting them apart, or may not involve the shaft at all but merely separate one of the condyles or a part of a condyle from the rest of the bone. Sometimes small pieces of the bone are torn up by strains on the crucial ligaments. The last two varieties are very rare.

FIG. 241.

Separation of lower femoral epiphysis. (BRYANT.)

The epiphysis, which includes the entire condyloid portion of the bone, may be detached in persons not over twenty years of age. The line of fractures just above the condyle is usually oblique, but a transverse direction is said to be more common than when the bone is broken at a higher point. The lower fragment in fractures above or through the condyles is frequently displaced backward and may, by pressure upon, or laceration of, the popliteal vessels, cause gangrene of the leg. The same result may follow similar displacement of the upper fragment.

The usual symptoms of fracture are present. The lateral mobility possible above the knee, the backward displacement of the lower frag-

ment and the leg, and the prominence and unusual mobility of the patella in supra-condyloid fracture, or its sinking between the separated condyles in inter-condyloid fractures, are additional aids to diagnosis. A pointed upper fragment is sometimes driven into the fibres or tendon of the four-headed extensor muscle or thrust through the integument. Effusion or hemorrhage into the knee-joint is particularly common in fractures involving the condyles.

Death from suppurative arthritis or gangrene, though not frequent, is a possibility to be remembered in giving a prognosis; and more or less ankylosis of the knee is quite usual, especially when the joint is invaded by the fracture line.

The proper treatment is permanent horizonal traction, as in fracture of the shaft, with even greater care to keep the knee-joint immovable. This immobility may be attained by a pasteboard splint adjusted to the back of the joint. The adhesive strips for traction should extend along the limb only as far as the knee. If the straight posture does not maintain the lower fragment in proper position, the knee may be partially flexed by placing a pillow or a double inclined plane under it, or by using a Smith's anterior splint. Severe arthritis is an argument for the completely extended position, since, if ankylosis occurs, a straight knee is more useful than a slightly flexed one. If the distention of the joint with fluid is too great to allow the joint to be completely extended, the fluid may be partially withdrawn with an aseptic aspirator needle.

If spasm of the gastrocnemius muscle prevents adjustment of the lower fragment, tenotomy of the tendon of Achilles may be justifiable, to weaken the displacing cause. If the upper fragment is buttonholed and so tightly held in the substance of the extensor tendon that reduction of the fracture is impossible, its liberation by subcutaneous or open section of the muscle is proper. Arthritis, if severe, requires appropriate treatment. The formation of pus in the joint is a demand for immediate incision under antiseptic measures.

Fracture of a single condyle is a very rare injury and, owing to the slight deformity attending it, may be mistaken for a sprain or arthritis of the knee. The integrity of the other condyle and the attachment of the broken piece of bone to the tibia prevent shortening and marked displacement. Suppuration of the joint has followed condyloid fracture. The diagnosis is to be made from localized pain and ecchymosis, motion and crepitus. Horizontal traction with care to correct any lateral deviation at the knee is the treatment; though a long fracture box or a posterior splint may do equally well. The joint should be kept immovable for three or four weeks. These fractures, and those in which small splinters of bone are torn off within the joint, resemble in their symptoms severe sprain, and should receive much the same treatment.

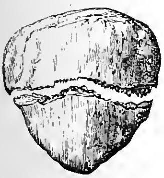
Fractures of the Patella.

PATHOLOGY.—The patella is broken generally by sudden and forcible contraction of the four-headed extensor of the leg, and occasionally by direct violence. The patient usually attributes the fracture to the fall upon the knee; but the fall in most cases is due to the previous giving way of the patella from muscular strain exerted upon it, for it is a sesamoid bone in the tendon. A slip of the foot occurs, and, as the man tries to save himself from falling, the violent muscular contraction bends the

patella across the condyles and fractures it by the cross-breaking strain, or else tears it asunder simply by the powerful traction upward. A similar result may occur in efforts at kicking or lifting. This usual causation of the fracture is proved, in the history of some cases, by the fact that in falls upon the bent knee the impact is received on the head of the tibia rather than on the patella, and by the further circumstances that the line of fracture is usually transverse, that in fractures known to be caused by direct violence the bone shows vertical, oblique, or comminuted fractures, and that no bruise is seen over the patella in the ordinary cases.

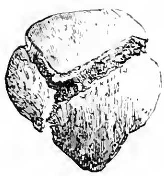
The fracture from muscular contraction is usually more or less transverse, is situated near the middle of the bone, and is generally repaired by fibrous union. Comminuted and oblique fractures usually unite by bony instead of fibrous tissue.

Fig. 242.



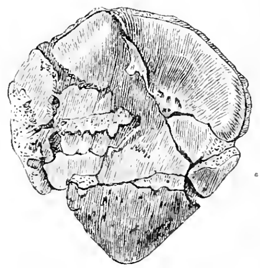
Transverse fracture of patella.

Fig. 243.



Oblique fracture of patella.

Fig. 244.



Bony union of comminuted fracture of patella. (Gurlt.)

The transverse fracture, from muscular action, is so much more common than any other that the subsequent description refers to it, unless otherwise stated. The lower fragment retains its normal position; but the upper one is drawn upward by the muscle and pushed upward by the rapidly occurring intra-articular effusion, until the separation amounts to half an inch or an inch. If the muscular aponeurosis surrounding the bone is greatly torn, the displacement may be much greater; and, on the other hand, if the fibrous envelope is not ruptured, the fragments may remain in contact. Lateral displacement may at times occur, but in any marked degree is not common. Some tilting of the fragments due to the surgeon's dressing or to the intra-articular effusion is not unusual. The fragments may thus be tilted so that they are in contact at one side, but separated at the other, or may be so everted that the fractured surfaces are directed in an anterior direction.

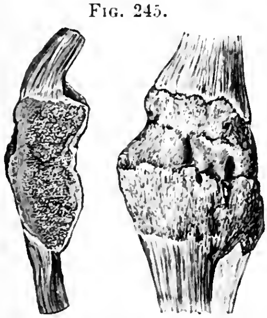
Symptoms.—The symptoms are a sudden loss of extending power at the knee, often accompanied by a sharp snap at the moment the bone gives way; pain, difficult progression, though walking is often possible if care is taken to keep the tibia and femur in a straight line and the heel to the ground; a well-marked furrow felt with the finger between the fragments, independent mobility of the upper and lower parts of the bone, with crepitus when they are pressed together and moved laterally; and swelling of the knee from blood and inflammatory products within the synovial cavity of the joint and the surrounding structures. The arthritis accompanying the fracture does not give rise to the intense pain

so common in other cases of synovitis of the knee, probably because the tearing open of the joint prevents intra-articular tension. The patient is unable to extend the knee after it has been flexed, or to raise the foot from the surface of the bed upon which he lies. The disability, however, varies, as would be expected, with the amount of laceration of the tendinous aponeurosis surrounding the patella. The bone has the vastus muscles inserted into its lateral margins and the general aponeurosis spread over its front. Hence, extension of the knee may be accompanied to a limited degree by such untorn attachments, even after fracture of the patella. In vertical and many comminuted fractures the extending power will be interfered with only by reason of pain. The joint-effusion will be absent if the case is seen immediately after the injury.

The diagnosis is readily made by palpation and the symptoms above described. Fractures with little or no separation, and traumatic bursitis in which the bursa in front of the patella is filled with blood and inflammatory products, may need careful consideration before a correct understanding of the lesion is obtained. It is said that crepitus and the feeling of separated bony fragments may be simulated by blood-clots in the bursa. The filling of the prepatellar bursa with fluid secreted by its own wall, or with synovia entering it from the joint, with which communication is mutually established by means of laceration of the bursa and the cleft in the bone, may prevent accurate determination of the exact line of fracture. After about ten days have elapsed the swelling of the joint decreases, and, if the pieces of bone are in close contact, a short fibrous, in rare cases an osseous, bond of union is established.

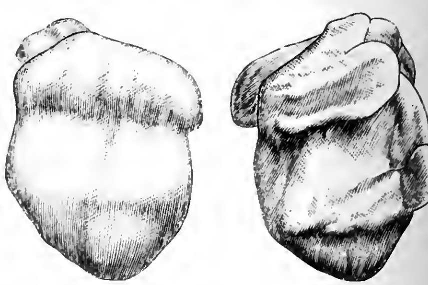
The fibrous union is often a long one, even measuring three to four inches, and the separation of the fragments may increase on flexion of the knee if the upper fragment has become adherent to the structures on the front of the thigh. Sometimes the bond of connection is little more than a condensation of the fascial structures, and seems not to partake of the nature of an attempt at repair. Use of a quite well-repaired fracture of the patella has often caused the fibrous union to stretch, and stretching may be greater on one side than on the other. Osseous union occasion-

Fig. 245.



Bony union of fractured patella. (Bryant.)

Fig. 246.



Close ligamentous union resembling bony union. (Levis's specimen in Mütter Museum.)

ally takes place, but many close fibrous unions have been mistaken during life for bony repair. Nodules of bone are at times found in the fibroligamentous tissue between the fragments. Rupture of the bond holding the pieces together, or fracture near the point of union, is not infrequent.

Such secondary accidents show at times little attempt at union. When the tissues have become rigid and adherent about the seat of fracture, and there still remains some stiffness of the joint, the integument may be torn and the joint laid open at the time the secondary fracture occurs. The open fractures so caused or originally open are, of course, very serious injuries.

FIG. 247.

Ununited fracture of patella, from cast.

A severe arthritis may leave a very stiff knee; and, even in ordinary cases, free motion of the limb is not attained for six months or a year. This is partly due to the fear of tearing or stretching the ligamentous union by early attempts at motion, which induces the surgeon and the patient to insist upon protracted wearing of splints and abstinence from strong passive movements. The fear is a well-grounded one. After freedom of flexion and extension of the joint has finally been gained, the disability from fibrous union, even an inch in length, is not very great. The patient may scarcely limp; though a rapid gait or the ascending and descending of stairs will show his imperfect power of control over the knee. Going *down* stairs is especially troublesome. Active extension of the joint will probably be possible only when the limb is put in an almost straight position.

TREATMENT.—In treating fracture of the patella, inflammation of the joint should be moderated and a short bond of union secured. These at least are the objects to be sought. Usually rest is all that is required to effect the first result. Cooling lotions may be employed if the arthritis promises to be severe. When there is very great intra-articular effusion, existing as late as ten days or two weeks after the receipt of injury, aspiration of the joint with an aseptic aspiration needle may be performed. The small size and irregular margins of the fragments, their being imbedded in a tendinous aponeurosis which is attached to the bone at the anterior edge of its margins, and the convex surface of the condyles on which the fragments rest, all make accurate adjustment by encircling dressings difficult and unsatisfactory.

The best treatment for the majority of cases is obtained by drawing the fragments together by means of steel hooks thrust through the skin and

imbedded in the tendon above and below the upper and lower fragments respectively. The hooks devised by Malgaigne are effective, but on account of the irregular shape of the bone do not permit as accurate coaptation as do those devised by Levis. These latter are separated pairs and can, therefore, be introduced parallel to each other or at an angle; varying with the line of fracture and tendency to irregularity in the displacement. Each pair of hooks has its points held together, after coaptation of the fragments, by a screw or by a lateral clamp.

Fig. 248.

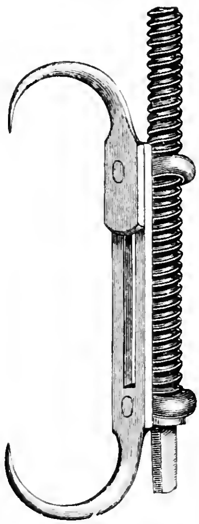
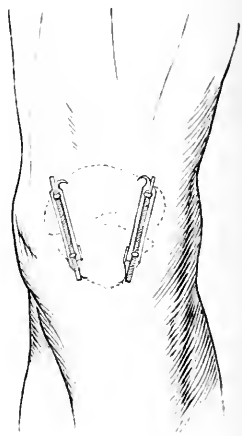


Fig. 249.



Levis's modification of Malgaigne's patella hook.

To get rid of the muscular displacing cause the leg should be kept fully extended on the thigh, and the thigh perhaps slightly flexed on the pelvis. This is readily done by elevating the limb on an inclined plane; or by supporting it with pillows after placing any form of rigid splint behind the knee. This position relaxes the three muscular masses arising from the femur and also the rectus, which has its origin from the pelvis. Absolute rest in this position for about a week, with perhaps the application of cooling lotions, will cause absorption of the articular effusion which aids in separating the fragments. If it does not, aspiration is justifiable. At the end of this time the fragments can usually be pressed together by the surgeon's fingers and held while the hooks are inserted, so as to keep them closely approximated. It is best to put the lower hook of the pair in position first; and then the upper fragment, which is the displaced one, can be controlled by the insertion of the second hook.

The points of the hooks must be sharp, and should be thrust as deeply as possible into the tendon close to the margin of the bone. There is no danger of entering the joint, for the tendon is very thick and tough. After one pair has been inserted the other is to be placed where it will best hold the fragments firmly together. The skin should be drawn tightly over the knee-pan before the hooks are inserted, and both the surface of the skin and the hooks cleaned and made aseptic. Ether may be required

in some patients, since the operation is rather painful, though not a tedious one. The points of puncture and the surrounding skin should be dusted with boric acid or iodoform, and the parts surrounded with a dressing of dry antiseptic cotton or gauze.

The hooks should be kept in place for six weeks; and, when removed, the patient, though using crutches, should wear a posterior splint for five or six weeks longer, in order not to tear the broken bone asunder by suddenly flexing the joint. Sometimes the hooks may need tightening once or twice as the swelling subsides, but usually no change is required. Their removal from the first punctures is not to be expected until they are finally taken out. The irritation produced by the hooks is inconsiderable. If a tendency to erysipelas or abscess about the punctures is feared because of the unhealthy condition of the patient or for any other reason, the hooks should not be applied; or, if already applied, they should be removed. Under such circumstances the adhesive plaster dressing is probably as simple and efficient as any.

The adhesive plaster dressing is applied as follows: After the knee has been extended and the entire limb elevated, the middle of a strip of adhesive plaster about two feet long is placed on the skin beneath the lower patellar fragment, and its ends carried upward and crossed upon the back of the thigh. By two or more strips applied in a similar manner, but not exactly corresponding with the first, the lower fragment is steadied. Then similar overlying strips are placed above the upper fragment and used to draw it down toward the lower one. The ends are crossed on the back of the calf of the leg. Over the whole a roller bandage is applied from foot to hip, and the limb kept extended and elevated by an inclined plane. Renewal of the adhesive plaster will be required about once a week, during the six weeks that the dressing is used before permitting the patient to be up on crutches. In applying this and similar constricting dressings there is a great tendency to tilt the fragments so that the anterior edges of the broken surfaces are further apart than the posterior. Perhaps this may be avoided by one or two strips carried directly around the front of the knee-joint.

For a long time after discarding all apparatus and crutches the patient should support the patella by wearing a knee-cap of elastic webbing.

Open fractures of the patella should be treated by free incision into the joint, washing out the synovial sac with a five per cent. solution of carbolic acid, a sublimate solution (1 : 2000), or beta-naphthol solution (1 : 2500), and free drainage by tubes. If the opening is very small and the injury just received, the attempt to convert the fracture into a closed one without free incision may be proper; but the first sign of joint inflammation is a signal for free incision, antiseptic washing, and drainage. The use of the hooks or the adoption of a simple posterior splint to maintain the extended position will necessarily be the treatment in all such cases, since the adhesive plaster dressing and similar devices can scarcely be applied. The drainage-tube need not, as a rule, be retained over a week.

Rupture of the bond of union or refracture of the patella should be treated as the original fracture. Sometimes the tendon of the great extensor mass of muscles is torn from the upper edge of the patella by the same mechanism that usually breaks the bone. The treatment, as well as the symptoms, is similar.

The treatment of fractured patella by wiring the fragments, and the management of cases with long fibrous union by resection and wiring are

not justifiable. The disability resulting from imperfect connection of the fragments is not great enough to warrant the additional though slight risk to life assumed. Such, at least, is my opinion. I am prepared to have the fracture in my own person treated by the hooks, but not by wiring. Therefore, I recommend one and condemn the other.

Fractures of the Tibia and Fibula.

The tibia and fibula are each developed by three ossific centres, one for the shaft and one for each extremity. The upper epiphyses unite at about twenty-five years of age, the lower at about twenty years. Occasionally the tubercle and malleolus of the tibia develop from separate centres. The possibility of epiphyseal separations occurring when the bones of the legs are subjected to violence should be recollected. Such diastases are, however, very rare.

Fractures Near the Knee.—Fractures at the upper end of the tibia, which usually are accompanied by fibular fracture, are frequently transverse, and may, by more or less vertical lines, invade the knee-joint. If the fibula is neither broken nor dislocated, it aids in preventing displacement. Epiphyseal separation here, as elsewhere, is liable to interfere with growth of the bone in length. Hence the uninjured fibula as it grows must either become bowed or dislocated at one of its ends.

The usual symptoms of fracture may be associated with those of synovitis of the knee, or of injury to popliteal vessels and nerves. The prognosis is serious because of the possibility of ankylosis, suppurative arthritis, and other complications. The fibula is seldom broken at its upper end, except when the tibia also is fractured.

Fractures of the Shaft of the Tibia and Fibula. Pathology.—The tibia alone is seldom broken except when the fracture is due to direct violence, such as a kick on the shin. The line of fracture is then apt to be somewhat transverse. The fibula, being the smaller bone, may readily be broken while the tibia remains intact. If both bones are involved, the fibula is likely to give way at a higher point than the tibia. The most common point of fracture of the bones of the leg is near the junction of the middle and lower thirds, and a frequent displacement is projection of the upper fragment forward and inward while the lower fragment is drawn upward, behind the upper fragment, by the great muscles of the calf. The subcutaneous situation of the tibia makes perforation of the integument and the conversion of the fracture into an open one quite frequent.

Symptoms.—The symptoms of fracture are easily discernible, especially when both bones are broken, since mobility and deformity are then present to a greater extent than under the opposite condition. The tibial crest and inner surface are so easily felt through the thin overlaying tissues that deviation in outlines here can scarcely be missed unless sufficient time has elapsed for the development of the great swelling which so often happens. Patients have occasionally the ability to walk upon a broken tibia, and even when both bones are fractured such a feat is not impossible. Walking after fracture of the fragile fibula is neither surprising nor uncommon. If it has been ascertained that the tibia is broken, fracture of the fibula may usually be assumed, unless the history is that of an injury of a localized character received in the tibial region. If the fact is not evident from the general deformity and preternatural mobility of

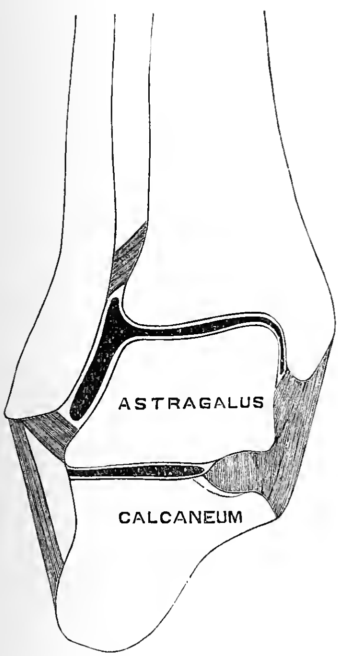
the limb, pressure along the fibula may perhaps elicit pain, crepitus, or yielding sufficient to establish the fact of its fracture.

When such evidence is not at once obtained, repeated and vigorous attempts at developing symptoms of fracture of the fibula are not wise or justifiable, unless the treatment is to be influenced by such knowledge, which is rarely the case. The formation of blebs on the surface of the leg, great swelling, violent cellulitis, and fat embolism are not unusual accompaniments of the severe injuries that give rise to fractures of the leg bones.

Union in uncomplicated cases of tibial fracture is firm in five or six weeks; in fibular fracture in from three to four. The bridge of callus occasionally uniting the bones after cure is of no evil consequence, since rotation is not a function of the leg and foot, as it is in the upper extremity. Non-union is not so very infrequent, and when occurring is probably often occasioned by imperfect immobilization due to faulty dressings. Comminuted and very oblique fractures require more time for consolidation. Neuralgic and rheumatic pains, persistent œdema, rigidity of the ankle, and chronic ulcers from defective restoration of circulation are not unusual sequences of fractures in the leg.

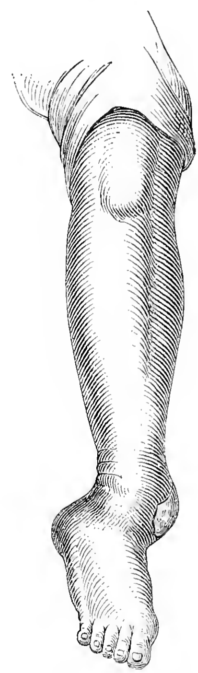
FRACTURES OF THE TIBIA AND FIBULA NEAR THE ANKLE. PATHOLOGY.—These injuries are frequent and often very serious injuries

FIG. 250.



Vertical section of bones at ankle-joint. (TILLAUX.)

FIG. 251.



Deformity after a bad fracture at the ankle. (STIMSON.)

Both bones may be broken without complication, they may be greatly shattered with the ankle-joint involved, the fibula alone may be fractured,

or one or both malleoli may be separated from the corresponding shaft. The lower end of the tibia is scarcely ever broken without the fibula being similarly injured, though the fracture of the latter bone may be two or three inches above its tip. In making this statement I refer to the base of the tibia and not to its malleolus, which can readily be chipped off without the fibula sustaining any fracture.

On account of the mortise-like manner in which the astragalus fits between the malleoli, lateral mobility of the normal ankle-joint is impossible, though it is simulated during the extended position of the foot by the slight rotation about a vertical axis which is possible. Lateral motion between the tarsal bones is sometimes mistaken for lateral movement in the ankle-joint. The impossibility of other motions than flexion and extension renders the occurrence of bad fractures common when falls, twists, or direct violence tend to forcibly evert or invert the foot at the ankle-joint. By such mechanism one bone may be fractured, or one malleolus may be torn off by avulsion through the lateral ligament; while the other is broken from the shaft by the astragalus within the joint being driven against its inner surface. Instead of involving the malleoli only, the force may fracture the tibia and fibula above the malleoli, rupture the ligaments holding the lower ends of these two bones together, and even so displace the foot laterally as to drive one of the bones through the skin.

The dissolution of integrity of the inferior tibio-fibular ligamentous bond allows, by widening the mortise in which the astragalus lies, lateral mobility in the joint, and suggests severe damage to the articulation, unless examination shows that the line of fracture has been limited to one of the malleoli or to the fibula above its malleolar extremity. Occasionally the astragalus has been actually driven up between the tibia and fibula.

Fig. 252.

Diagram showing frequent fracture-lines from forcible eversion and abduction of foot. (Stimson.)

Fig. 253.

Fracture of tibia and fibula at ankle. (Gross.)

Symptoms.—The symptoms in the majority of cases are characteristic of fracture, though occasionally it is necessary to examine the malleoli and fibula carefully in order to avoid calling the injury a sprain. Localized tenderness and ecchymosis will often be determining symptoms in obscure fracture of these parts. "Sprain-fracture," or sprain with detachment of a small piece of bone from the end of the malleolus, is not un-

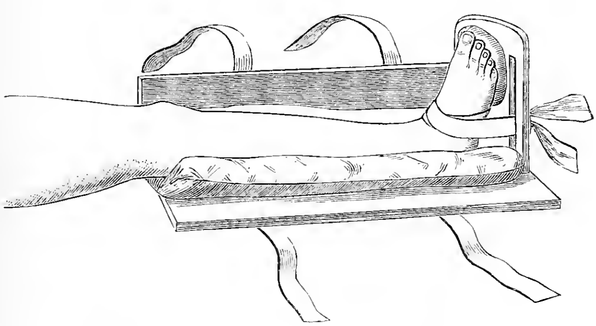
common at the inner malleolus. The fracture of the fibula may be two and a half inches above its tip.

In the form of injury depicted in Fig. 253, which is quite common, the foot is displaced to the outer side, the inner malleolus prominent, the sole of the foot everted, and the heel apparently elongated. There is sometimes a groove on the outside of the ankle at the point where the fibula has given way. Pain and ecchymosis will probably be found in both malleolar regions, and lateral mobility at the ankle-joint will be detected if the calcaneum and astragalus are seized with one hand while the lower end of the leg is grasped with the other. Motion in the tarsal joints must not be mistaken for ankle motion.

Fracture of the lower part of the fibula can often be detected by placing the fingers behind the upper third of its shaft and endeavoring to lift it forward. If this causes pain about the lower portion of the bone, it is evident that the fibula is fractured and movable at the point of pain. This test has often been very serviceable to me in obscure injuries about the ankle.

Uncomplicated fractures about the ankle, without much displacement or with easily corrected displacement, give good results and do not leave any very great final stiffness. The period of union is about five weeks, but it requires many weeks to restore the mobility of the ankle. Where there is great deformity and the eversion or inversion of the foot cannot be overcome, permanent disability results from the weight of the body being carried on a foot out of proper line. The strain on ligaments and bones in the unusual relations creates lameness and a tendency to increased deviation from the normal axis. Open fractures in which suppuration occurs are of serious prognosis, because, when restitution of position is made, the external wound frequently does not correspond with the point of fracture, and decomposing secretions are retained. Free incisions and the introduction of drainage-tubes may not only avert amputation but save life. Ankylosis is common in bad fractures entering the joint. Such fractures, especially, should be treated with the foot at a right angle to the leg.

FIG. 254.

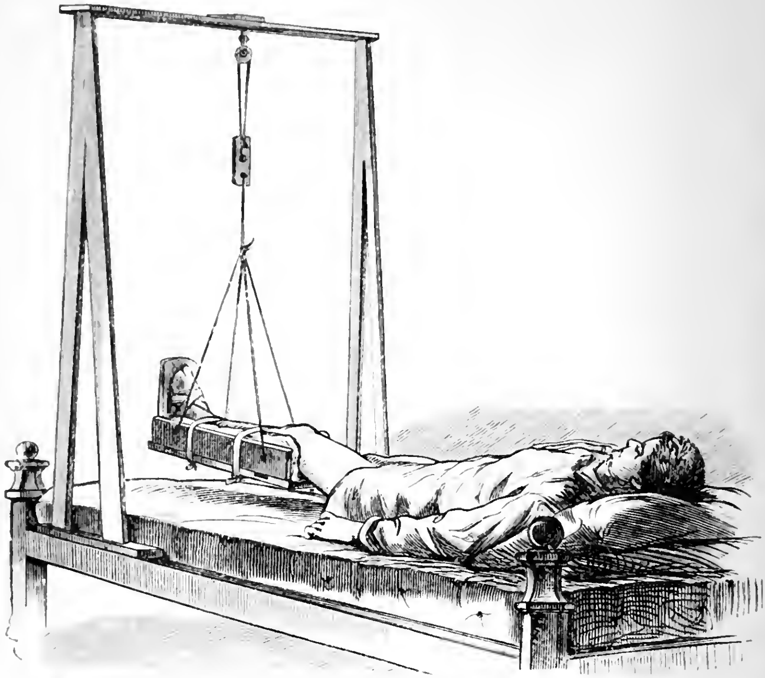


Method of adjusting the leg in fracture-box.

TREATMENT.—There are few fractures of the bones of the leg that cannot be properly treated in a fracture-box, with hinged sides and foot-piece, and appropriate compresses. Continuous horizontal traction can be added to the box, if the case is such as to demand it. Unless traction is simultaneously used, and it is seldom required, the box should be suspended, because thus the patient can have greater freedom of motion in bed without danger of displacing the fragments.

The fracture-box is prepared by opening its hinged sides and laying within it a small feather pillow just large enough to fill the space which

FIG. 255.



Suspended fracture-box, with slide on cord by which box can be raised or lowered. (AGNEW.)

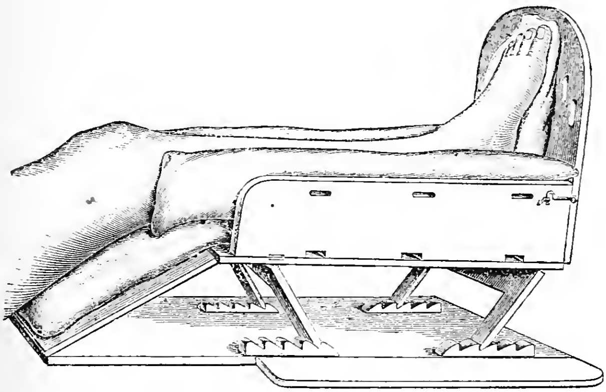
would exist between the leg and the inner surface of the box when the sides are closed. Upon the pillow, close to the footboard, should be placed a ring of oakum, tow, or cotton to receive the point of the patient's heel; and over the ring a strip of bandage two feet long should be laid. The leg is to be placed upon the middle of the pillow, with the ankle bent at a right angle and the foot close to the footboard, from which it is separated by only a soft compress. The foot is affixed to the footboard by the ends of the piece of bandage mentioned being carried over the top of the foot, where they are crossed, carried through the slots in the footboard and tied on its outside. The next step is to raise the sides of the box, by which means the edges of the pillow are pressed against the broken limb, and to hold them in position by pieces of bandage drawn underneath the box and tied over the top. The amount of pressure exerted by the sides of the box, which act as lateral splints, can

FIG. 256.

Slide by which fracture-box is raised and lowered. (AGNEW.)

be regulated or changed by tightening or loosening the encircling strips of bandage or altering the thickness of the pillow. If any lateral deviation in the line of the leg is observed by running the finger-tip along the crest of the tibia, it can be corrected by compresses slipped between the sides of the box and the pillow at the appropriate places. Anterior or posterior displacement can usually be overcome by elevating or depressing the heel, which is done by increasing or diminishing the size of the ring used to prevent a bedsore on its tip.

FIG. 257



Elevated fracture-box. (STIMSON.)

No primary bandage should ever be applied to the leg from the toes to the knee, as the danger of gangrene produced thereby is too great. In suspending the fracture-box, which should always be done except in some fractures close to the knee-joint, and in those which require horizontal traction from the foot, cords should pass through openings in the upper part of the sides of the box and be attached to a single cord carried to a pulley fastened above the bed. It is easy to devise methods by which the height of the box from the bed may be changed to suit the patient. The posterior end of the box must not be allowed to drag on the bed, nor should any position be assumed which tends to permit motion or displacement at the site of fracture. Rotary displacement is a particularly unfortunate deformity, as permanent inversion or eversion of the toes is unsightly and interferes with walking. The surgeon should see to it that the ball of the great toe, the inner malleolus, and the inner condyle of the femur are in the same vertical plane, or that the great toe is on a line with the inner edge of the malleolus. When muscular contraction prevents complete reduction at the first dressing, flexing the knee and extending the foot will relax the calf muscles. Stimson says that compression of the femoral artery for a few minutes has induced for him relaxation of the muscular spasm. Subcutaneous section of the tendon of Achilles is rarely necessary.

When the fracture is at the upper part of the leg the knee must be kept immovable; hence the fracture-box should extend above the knee, which is to be kept straight or slightly flexed, according as one or other posture favors accurate adjustment of the fragments. If flexion is necessary, a double inclined fracture-box like that used occasionally for frac-

tured femur may be needed. It is not easy to suspend this form of box, nor is it necessary; but, with the knee in a straight box, suspension is readily accomplished. The synovitis, often complicating, should be watched, and if purulent must be treated by incisions, antisepsis, and drainage.

In very oblique fractures of the shaft continuous longitudinal traction may be needed to correct the over-riding. This can be attained by elevating the foot of the bed as in femoral fractures and attaching a weight to the footboard of the box, after placing under the box a smooth board or kind of railroad upon which it can slide up and down. Another method is to apply a stirrup to the leg, as in fractures of the femur, but by means of shorter adhesive strips, and to substitute for the fracture-box lateral coaptation splints or sand-bags. When the fracture is too low to give sufficient attachment for the plaster, a thin board may be cut in the shape of the sole and attached to the foot by strips of plaster. To this footpiece or sandal, cord and weight can be fixed, and the lateral splints then applied to the leg.

When the fibula alone is broken, when one of the malleoli is split off, and even when the tibia itself is fractured, if the line is transverse and the fibula intact, little support is needed. Hence the fracture-box may be discontinued in a week, and the patient allowed to go on crutches with the circular gypsum dressing. This should be worn for about three weeks.

In those cases of severe fracture at the ankle in which the foot is greatly everted or inverted, it is of primary importance that the correct axis of the foot should be regained. Hence it is necessary to over-correct the deformity by *inverting* the *everted* foot, or *everting* the *inverted* foot, and keeping it so till some degree of consolidation has occurred, This being neglected will permit union to occur without reëstablishing the close mortise between the malleoli in which the astragalus fits, and thereby will leave a want of solidity at the ankle. The projection backward of the heel must also be corrected by elevating it in the fracture-box. Backward displacements can sometimes be well corrected by passing a piece of adhesive plaster under the heel or ankle with its adhesive side against the skin and tacking its ends to the upper and outer part of the sides of the box. The fracture-box, with the judicious use of compresses and the other adjuvants mentioned previously, will accomplish these indications as well, if not better, than more complicated dressings.

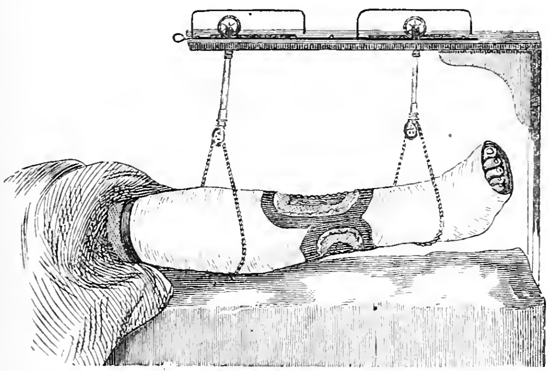
In many fractures the great swelling will for some days permit the sides of the box to be only partially closed, hence the strips of bandage will need tightening frequently. The box should at first be opened and the leg examined once or twice daily. Afterward it may remain undisturbed for a week, if no burning of the heel or discomfort suggests bedsores or displacement. The blebs frequently seen on the surface, even if containing bloody serum, are of no importance as a rule, and need no treatment. If large, they may be evacuated with a sterile needle and afterward be covered with powdered boric acid. They soon dry up. They are, perhaps, due at times to the unnecessary swathing of the broken limb in lead-water and laudanum, or similar lotions, which are often employed immediately after the fracture. Such applications are often used with the idea of lessening the inflammation, but their virtue in moderating the deep inflammation existing is problematical. Time is the element required.

At the end of a week in uncomplicated fractures and after the lapse of

from three to five weeks in more serious cases, the box should be discarded and the circular gypsum dressing applied from the base of the toes to the knee or above it. The patient can then go about on crutches. When the fracture is at the ankle the dressing should be made additionally firm there by extra turns of the bandage. The foot should in such cases be held in the correct position for from fifteen to thirty minutes, till the gypsum sets firmly. Care must be observed in order that the tarsus itself may be pressed over, and not merely the anterior part of the foot. The gypsum cast should be worn about three weeks in all cases.

Open fractures, not demanding immediate amputation, are well treated in a fracture box after being made thoroughly aseptic and being surrounded by a large gauze dressing. Drainage must be well arranged, even if additional incisions are needed for the purpose. Free drainage and frequent irrigations are demanded if the fracture cannot be converted into an aseptic wound. When union has become pretty firm, or earlier

Fig. 258.



Van Wagenen's suspended fenestrated gypsum dressing for open fracture of the leg. (Hamilton.)

if profuse discharge has ceased, a fenestrated gypsum dressing may be substituted for the fracture-box. The device of Van Wagenen, described by Hamilton, is especially nice for suspending such gypsum dressings, and it allows the patient to turn on his side and slide up and down in bed. Crutches are allowed when the fracture becomes firm.

Fractures of the fibula have been discussed with those of the tibia; hence little further need be said. Injury of the peroneal nerve is sometimes an accompaniment of fibular fracture, and is shown by paralysis. Localized pain and crepitus, and pain felt at the seat of tenderness when the upper part of the shaft is lifted as previously described, are diagnostic symptoms, but are not always present. When the fracture is low down and accompanied by spreading apart of the malleoli, lateral motion of the astragalus becomes possible. The upper end of the fibula has occasionally been broken from the shaft by violent contraction of the biceps muscle. In such cases flexion of the knee to relax the muscle will be a judicious measure during treatment. Union after fibular fracture occurs in three or four weeks. When the fibula alone is broken the fracture-box can be dispensed with in a day or two and the gypsum dressing applied. In some cases nothing more than a bandage is needed from the first.

Fracture of the Bones of the Foot.

These lesions are usually the result of severe violence, which is often direct; hence many cases present, in addition to the fracture, great damage to the soft parts. Comminuted and open fractures are, therefore, common; and amputation or excision of bone often required. Very little apparatus is, as a rule, sufficient to immobilize fractures of the foot, because the size and shape of the bones and the manner of mutual articulation does not favor a wide range of displacing motion. Union is to be expected in uncomplicated cases in three or four weeks, but ankylosis, caries, necrosis and prolonged disability often follow lesions of comparatively slight significance.

FRACTURES OF THE TARSAL BONES.—The astragalus and calcaneum are the only tarsal bones whose fractures require special discussion, as fracture of the astragalus is not infrequently associated with dislocation of the ankle and fracture of the fibula, or with calcaneal fracture. Marked displacement is not very common when the bone injury is unaccompanied by a wound leading to the seat of fracture. The diagnosis is difficult, because the crepitus, the inability to bear the weight of the trunk on the foot, the pain and swelling, may be due to fracture of the calcaneum or other tarsal bones. The treatment consists in reducing any apparent displacement and immobilizing the ankle and foot by a fracture-box or circular gypsum dressing. The foot should be at a right angle to the leg, and its sole neither everted nor inverted. In closed fractures, with extreme displacement of fragments, which cannot be overcome and which threaten, by tension on the integument, to produce ulceration, excision of the fragment may be performed at once under antiseptic methods.

In open fractures free incisions, counter-openings, drainage and antiseptics are essential elements of success. Febrile reaction and pain are often the surest indications that putrescent fluids are imprisoned. The best point for incision is probably between the extensor tendons of the great and second toes. Ankylosis will result, and hence the foot must be kept at a right angle to the leg during treatment. The body of the calcaneum may be broken by falls, the sustentaculum tali snapped cff by forced inversion of the foot, and the posterior portion of the calcaneum, where the tendon of Achilles is inserted, pulled off by the calf muscles. Flatness of the sole, increased breadth of the foot in the calcaneal region, approximation of the sole to the malleoli, and the limitation of crepitus, pain and motion to the known location of the calcaneum are the distinguishing features of these lesions, which are often obscure in diagnosis. Fracture of the ledge of bone on the inner and upper aspect, called the sustentaculum tali, is said to allow sinking of the inner malleolus and eversion of the foot, and to be attended by shortening of the heel, as shown by measuring around the back of the heel from one malleolus to the other. When the posterior part of the os calcis is detached by muscular contraction, the small fragment may be displaced upward two or three inches. The treatment comprises immobilization in a fracture-box or circular gypsum dressing; with care to obtain correct position of the foot when the sustentaculum tali has been broken, by moderate inversion. In muscular fracture of the point of the heel, flexion of the knee and extension of the ankle will usually be required to keep the fragment down in contact with the rest of the bone. A slipper attached by a cord to a band around the lower third of the thigh will accomplish this. If preferred, an anterior

splint may be moulded to the anterior surface of the limb and the dorsum of the extended foot.

Occasionally the force received tears out a little scale of bone at the point of attachment of one of the ligaments. The astragalus is subject to this lesion, which may be termed a "sprain-fracture," on its posterior aspect, where the external lateral ligament is attached near the groove for the long flexor tendon of the great toe. A similar lesion may occur at the point where the external ligament is attached to the calcaneum.

The metatarsal bones most often broken are those of the great toe, really by development a phalanx, and that belonging to the little toe. Metatarsal fractures show little deformity unless several contiguous bones are broken. Displacement, when it occurs, is apt to cause an angular projection on the dorsum of the foot. Pressure of a toe backward toward the tarsus will often, after injury, reveal fracture of the corresponding metatarsal bone by giving rise to pain at the suspicious spot. Immobilization by a circular gypsum dressing applied at once, or by a fracture-box, soon followed by the gypsum dressing, is the proper treatment. Open fractures and burrowing of pus must be met by drainage and antiseptics. If the deformity in either closed or open fractures is irreducible and of a character to produce lameness or to interfere with wearing a shoe, excision of the projecting portion of bone is justifiable.

Fractures of the phalanges are often compound, and in such cases immediate amputation may be done more frequently than in corresponding injuries of the fingers, because the deformity and disability is not as important in the foot as in the hand. The toe in other cases may be made immovable by strips of adhesive plaster holding it to the adjoining toe, by a gypsum dressing, or by a small pasteboard splint bound to the top of the foot and back of the toe by adhesive plaster. Serious inflammation not infrequently starts from these insignificant fractures.

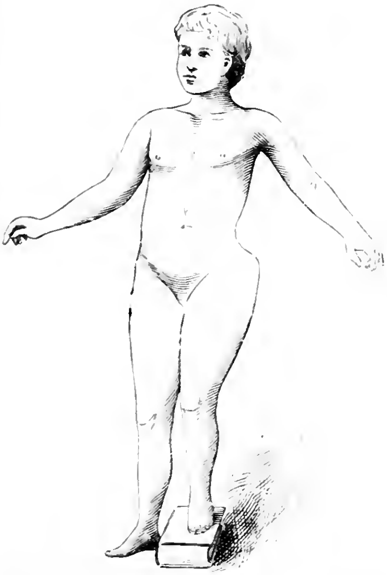
CHAPTER XVIII.

SURGICAL DISEASES OF THE JOINTS, CARTILAGES AND LIGAMENTS.

CONGENITAL DEFORMITIES OF JOINTS (CONGENITAL DISLOCATIONS).

THESE deformities arise either from intra-uterine traumata or from nervous or other causes, which may arrest development in portions of the embryo. Fortunately, they are of rare occurrence, taking place principally at the hip; although the jaw, shoulder, knee and almost any joint may be affected. They are frequently found associated with such other congenital defects as club-foot, spina bifida, exstrophy of the bladder, ventral hernia or encephalocele.

FIG. 259.



Unilateral congenital dislocation of the hip. (KRÖNLEIN.)

FIG. 260.

Double congenital dislocation of hip. (STIMSON.)

Treatment of these dislocations is apt to prove unsatisfactory. Reduction should always be attempted, but very rarely, if ever, will the effort be crowned with success, as the joint is more or less defective in construction or portions may be entirely absent. Most usually merely rudimentary elements of a joint exist; when palliative measures alone are

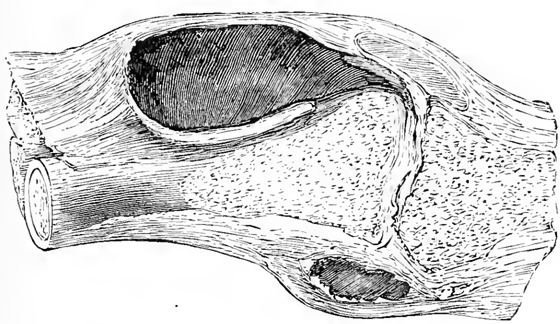
permissible. All means calculated to aid in the formation of a false joint should be employed, even to dividing contracted or constricting tissues, or the neck of the femur. In case of the hip-joint an apparatus combining a tight band around the loins to force the femoral head against the ilium, with a perineal band to relieve upward pressure is to be recommended.

Synovitis.

Synovitis is an inflammatory affection of the lining membrane of a joint. It occurs chiefly in adults, and may affect one or more articulations; none are exempt; but the knee, wrist, ankle and phalanges are most commonly involved. Certain diatheses, such as the rheumatic, tuberculous, and syphilitic, predispose, whilst contusions, sprains, dislocations, neighboring disease, and wounds act as exciting causes. A rigor, with slight elevation of local and general temperature, pain, and creaking upon motion, fixation, moderate swelling, and, a little later, effusion and fluctuation, mark its advent. The synovial membrane becomes blood-red in color and swollen, sheds its superficial cell layers and exudes serum, at first limpid or, perhaps, tinged with blood, which speedily becomes turbid, or, in the most intense varieties, purulent.

When located in the knee-joint, the patella is floated from contact with the femoral condyles when the leg is extended, and when pressed upon displaces the underlying fluid and comes into palpable contact with the bones beneath. Simple acute synovitis is to be treated by absolute rest in an extended position, by cold applications, local abstraction of blood by leeches or cups, counter-irritation by blisters, and, in some cases, by the application of firm bandages over wadding. Rest may be secured either by splint or extension apparatus, but it must not be persisted in longer than the more acute stage, when cautious passive motion and massage should be instituted to prevent adhesions.

Fig. 261.



Chronic synovitis of knee showing dilatation of synovial cavity by effusion. (Druitt.)

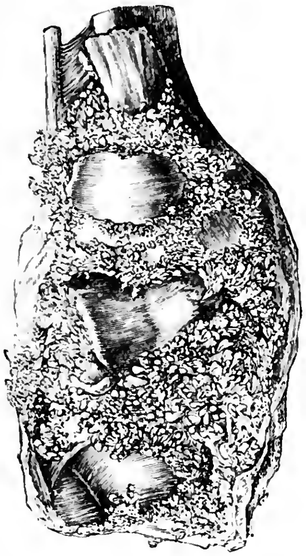
Should the affection, nevertheless, become *sub-acute or chronic*, these measures should be coupled with more decided counter-irritation, diuretics, cathartics, and later, should effusion persist, with aseptic aspiration or washing-out of the cavity.

Purulent synovitis is a serious complication, recognizable by recurring rigors, persistent high (103°) temperature locally, constitutional disturbance, and by hypodermic aspiration.

It is to be treated, first, by aspiration and washing-out of the joint, and, this failing, by incision and drainage, or by excision of the membrane if that alone is involved.

Septic synovitis is extremely resistant to treatment, often requiring in addition to the usual constitutional and local measures such operative procedures as will be described under arthritis, and as frequently resulting in ankylosis or destruction of the joint. Its cause, pathology, diagnosis, and treatment are practically identical with the septic form of the latter affection, as the process occurring in the synovial membrane invariably extends quickly to other structures of the joint.

Fig. 262.



Fibroid hyperplasia of synovial membrane of knee. (Druitt.)

Syphilitic synovitis much resembles simple acute and subacute synovitis, but is dependent upon and intercurrent with the constitutional disease, and promptly yields to anti-syphilitic treatment. It may be acute or chronic; is limited to adults; is symmetrical, and usually occurs in the knees. Some swelling and effusion accompanies it, but scarcely any pain. Occasionally synovial membranes undergo a fibroid change of probably rheumatic nature, and minute sessile or pedunculated whitish fibroid bodies are developed throughout the membrane. These, during movements of the joint, may become separated from their attachments and form a variety of "loose bodies" in joints. A second variety of this same process exists where the fibroid masses are developed in the deeper layers of the membrane. Here they become flattened by joint motion, and bear great resemblance to melon seeds, by which appellation they are commonly known. These and other fibroid changes of the synovial membrane occur in rheumatic arthritis.

Nothing short of excision of the affected membrane can afford any relief from these affections.

Primary and metastatic neoplasms of the synovial membranes rarely occur, but cannot, as a rule, be accurately diagnosed save by opening the joint. Effusion will usually be present.

Hæmarthrosis.

Hæmarthrosis results from laceration of the bloodvessels of the synovial membrane. It may occur in conjunction with synovitis, or exist separately. Blood quickly distends the cavity of a joint, but does not clot unless it has communication with a fracture. Marked fluctuation is

frequent, but there is usually no pain or increase of heat, and upon hypodermic aspiration pure blood is withdrawn. Small quantities of blood thus effused into healthy joints is rapidly absorbed under pressure, but otherwise must be withdrawn by aspiration. Persistent effusion after injury, without pain, will almost invariably prove sanguineous. Hæmarthrosis followed by degenerative joint change is common in hæmatophilics, when it should not be interfered with surgically, unless its causative condition has first been effectively cured.

Hydrarthrosis, or simple non-inflammatory infiltration of joints, is usually a part of a general œdematous condition of an extremity having origin in heart, liver, or kidney disease, or in venous obstruction or distention. It can only be relieved by removal of the ulterior cause, together with elevation and elastic pressure by bandages.

Arthritis.

When an inflammatory process has originated in or been engrafted upon other portions of a joint than the synovial membrane, it is termed arthritis. Practically, however, the distinction between synovitis and arthritis is frequently impossible and as often immaterial as regards treatment; the synovial membrane being invariably involved, either primarily, secondarily, or synchronously with other portions of the articulation. Arthritis may involve a whole joint or be limited to any portion of its extent. Identical varieties are apt to present at once more severe constitutional and local phenomena than do the corresponding forms of synovitis, but its development, on the contrary, occasionally is most insidious.

Simple acute or chronic arthritis takes place as a rarity. Almost all cases of arthritis are to be included in the chronic, septic, specific, and neurotic varieties.

Acute suppurative arthritis is a purulent inflammation of the entire contents of a joint. It may involve one or many articulations at once or consecutively. The causes are either contusions or wounds of the joints, contiguous inflammation as in epiphysitis, by burrowing of pus from periostitis beneath the periosteum into the joint, or rupture of an abscess of the bone head into the articulation. The pathology of the affection is simply that of acute suppurative inflammation of all the elements of the joint; the cartilages erode or necrose, purulent or saniopurulent effusion takes place, producing *abscess of the joint*, which subsequently may rupture externally or penetrate into the surrounding tissues. Finally, the joint may return to a non-inflammatory ankylosed condition, or necrosis of the adjacent bones may take place. Taking the knee, for example, pain increased by motion, chill, temperature rising to 102° to 104°, and swelling will be the initial symptoms. Fluctuation, great swelling and œdema, and severe constitutional depression with high pulse, will, together with aseptic hypodermic aspiration, render the diagnosis certain. Before the diagnosis of pus can positively be made, the joint must be put at rest by splints, and evaporative lotions, ice-bag, or irrigations applied. When pus is recognizable (sometimes when only suspected) the joint should be tapped and washed out, or, especially if pus recur, be laid open and drained. Constitutional support and stimulation, antiperiodics, and concentrated diet are of prime importance. Such treatment will sometimes save a joint and preserve fair motion, but

ankylosis is usual. Later stages will probably require excision or amputation. Except in pyæmic cases, these latter measures should, when indicated, never be delayed if the patient can withstand the shock, for the rule is constant loss of strength without recuperation whilst the suppurative process lasts, and the danger of further constitutional contamination is great.

Gonorrhœal Arthritis.

Gonorrhœal arthritis is caused by metastasis of gonorrhœal pus from the urethra, is almost limited to the male sex, and involves as a rule a single large articulation, but may be symmetrical, or attack any, even phalangeal joints. All parts of the joint are involved. There is great pain, worse at night, swelling and œdema; pressure and motion are extremely painful, and grating may be present. Plastic exudation, rather than effusion, takes place, which exudate commonly organizes into fibrous material which more or less completely obliterates and ankyloses the joint. The urethral discharge, which may be either from acute gonorrhœa or chronic gleet, is not usually in any way affected by joint involvement; but on the other hand, treatment of the discharge often has a marked beneficial effect upon the diseased joint and will prevent other articular involvement. Gonorrhœal arthritis is extremely resistant to treatment and very apt to pursue a long chronic course. Absolute rest, leeches, counter-irritation by a series of small blisters, morphia for pain, and a liberal use of belladonna and mercurial ointments upon the joints, in conjunction with good diet and hygienic surroundings, are the most beneficial remedies.

Tubercular Arthritis.

Tubercular arthritis usually takes origin from extension of tuberculous disease from the contiguous bone extremities, but may also arise primarily in the synovial membrane. The tubercle bacillus is invariably present, actively causative, and diagnostic. This form of arthritis is most common in childhood or youth, but may arise at any age. In aged persons the process is apt to run a rapidly destructive, almost irremediable, course, speedily breaking down the joint and involving adjacent bones. The strumous or tubercular diathesis invariably precedes and predisposes to joint infection, whilst depraved physical condition or slight traumata serve as exciting causes. It frequently follows such diseases as measles, scarlatina, and typhoid fever. The malady may be limited to one or several joints, or be concomitant with or consecutive to tuberculous lesions elsewhere.

Pathology.—Primarily tubercles are deposited in the articular extremities or membranes of the joint. Then follow irritative inflammation, serous succeeded by purulent effusion, distention and progressive softening of the joint capsule and ligaments, ending in their rupture or disappearance. The membranes and cartilages are replaced by a fibrous, gelatinoid, yellowish or brownish substance; the bone-ends are invaded, abscesses form and discharge, leaving sinuses from which sequestræ or granular portions of bone may be discharged. Finally, by continuous reflex muscular contraction, the bones forming the articulation are drawn asunder, giving rise to great deformity and disability. The process may be arrested in the earlier stages, when the parts may return to the normal

previous condition, or the inflammatory products may organize and produce intra-articular adhesions and more or less ankylosis.

Symptoms.—Slight impairment of function is earlier or later followed by pain and swelling. Pain may be absent until later; it is not essential, or at all characteristic. No impaired function even may be discernible at first, save on close examination. The temperature of the body or part may or may not be raised. Soon the articulation assumes a white swollen appearance; blue veins are apt to course over its surface, and upon palpation a sensation of "doughy" fluctuation is apt to be observed, which, later, will probably be succeeded by true fluctuation, lateral movement, grating, abscesses, sinuses, and discharge of disintegrated bone and cartilage, spiculæ or sequestra, and dislocation. Hectic will be present if the joints have become infected through the sinuses, but not if that accident has been prevented by proper treatment. If purulent discharge has been of long duration, amyloid disease may complicate the case and interfere with treatment.

Treatment.—Absolute rest of the joint for a long period, with good food, tonics, iron, cod liver oil, and such measures as have been suggested for synovitis and simple arthritis, such as cold applications, leeches, blisters over points of greatest pain, applications of iodine, and pressure by bandages, is the treatment for all but the later stages. Should the process still continue, excision of the joint membranes and other tuberculous foci in the cavity (erasion) is called for. Next in order comes excision, and, lastly, if the joint is utterly destroyed or the bones hopelessly involved, amputation of the extremity.

Prognosis.—Many cases appear to recover perfectly when the disease yields to minor measures; others preserve simply a stiff or ankylosed joint. Excision and erasion are very successful, if not left too late. But many live for years with discharging sinuses without much discomfort other than more or less loss of function. Constitutional infection is supposed to occur frequently, if the disease is not eradicated. Tubercular meningitis is not rare at any period. Amyloid degeneration of the kidneys and other organs sometimes results from continued purulent discharge. Joints cured by minor measures are liable to recurrence upon even trivial aggravation or injury.

Tuberculous Arthritis of Special Joints.

Tuberculosis of Vertebral Articulations (Spondylitis, Pott's Disease).

Tuberculosis of the vertebral articulations conforms, with modifications due to location, to the general description of joint tuberculosis. Thus situated the affection is most apt to develop between the third and sixteenth years, but no period of life, from a few days up to about the seventieth year, is entirely exempt. Any joint or joints of the spine, from the occipito-atloid to the lumbo-sacral or even inter-coccygeal, may be affected. The lower dorsal region is most usually involved; then, in order of frequency, come the dorso-lumbar, cervico-dorsal, cervical, lumbar, lumbo-sacral, atlo-axoid, occipito-atloid, and inter-coccygeal. The disease may develop simultaneously or secondarily in two or more distinct locations, or travel through a considerable number of contiguous vertebræ, either upward or downward. It may be an entirely local disorder, a manifestation of general tuberculosis, or itself may originate the latter.

The course of vertebral tuberculosis is, as a rule, slow and chronic, but exceptional cases and those which become infected through abscess openings may run a very acute and rapid course.

A history of traumatic cause or origin is almost always presented with the case. Slight direct or indirect traumata are probably determining and exciting causes, but the tuberculous constitution must be present to render them efficient. Violent injuries of these, as of other joints, are not likely to be followed by tuberculosis. It may arise from infected spinal wounds.

Pathology.—As the medulla and epiphyses of the vertebræ remain soft and embryonic until long after other cancellar tissues have undergone the permanent changes of adult bone, they are more predisposed to inflammatory affections than other bones. Hence, tubercle bacilli find a more congenial bone location in the pulpy osteo-cartilaginous or epiphyseal junctions of the vertebræ than elsewhere. At these points the disease in almost every case begins, although it is possible that some few originate in the inter-vertebral fibro-cartilages or synovial membrane, except in the occipito-atloid, atlo-axoid, and inter-coccygeal varieties, when the disorder commences as a tubercular synovitis or in the odontoid process. In every case the joints are quickly involved and adjacent cartilages and bone are broken down. The destructive process is always confined to the bodies of the vertebræ, while the laminæ and spinous processes escape. At this stage, before deformity takes place, the disease may naturally, or responding to treatment, cease, the products organize or casefy, and no special harm be done. But much more usually it progresses; the bodies of the vertebræ on either side of the first affected joint become carious and crumble down, or necrose and throw off sequestræ; the super-imposed portions of the spine are drawn forward and downward by gravity and action of the abdominal muscles, deformity results, abscesses may form and burrow in the peri-spinal sheaths and perhaps infect new portions of the column. If unretarded, the process may continue until many separate or contiguous vertebral bodies are destroyed, great deformity has supervened, and the patient finally succumbs to suppuration and exhaustion. Unless the case is complicated by old lateral curvature, the deformity is always directly antero-posterior, because the spinal arches, articular spinous processes, and the lateral supports of the column are not interfered with. The projecting portions of the deformity are due to the pushed-out spinous processes. Where the seat of the disease is situated in the lumbar region, deformity does not appear or comes very late, because the natural anterior curvature of the spine at this point must first be overcome before angulation can become evident, as well as because of the rigidity and broad articular surfaces of this region.

Suppuration is not a good index of the disease; it (abscess) may present in advance of other symptoms, or not appear until destruction is great. Some worst cases are never complicated by its presence. Abscess is discovered in about twenty-five per cent. of all cases, but it occurs without being fully demonstrable in as many more. At post-mortems they are usually found concealed or sacculated, and if the case recover the suppurative products may have organized, caseated, or have formed residual abscesses. A variety of vertebral tuberculosis has been recorded in which the bodies of the bones become honey-combed, but do not suppurate, break down, or produce deformity.

Contrary to conventional belief, angular deformity does not give rise to direct pressure upon the cord, except in rarest of instances, and when the

disease is located at the atlo-axoid junction. Actually, there is much more than the usual space for the cord to pass through when angular deformity exists, as then the anterior wall of the canal is replaced by an excavation. But such deformity by approximating the ribs may give rise to pressure symptoms or destruction of the nerves emerging laterally from the spinal column. In alto-axoid disease the atlas is displaced forward upon the axis, the posterior arch of the former compresses the cord more and more against the odontoid process of the latter, and gradual or sudden extinction of the functions of the cord, and death, may result. The paralysis of the more ordinary forms of the disease is due to secondary inflammatory affections of the cord and membranes, and to pressure from pent-up pus, hemorrhage, as from ulceration into the vertebral artery or other vessel, or from a displaced sequestrum. If the displacement or pressure be gradual in onset the cord will often accommodate itself to it, and can carry on its varied functions through a very much narrowed spinal canal. Therefore, it is not strange that many palsies of tubercular spondylitis are often erratic, anomalous, and, on occasion, the first symptom of trouble. Angular deformity in the cervical region forces the chin upon the chest and may produce dyspnœa, while in the dorsal region the same effect follows compression of the thoracic viscera, whence mechanical dyspepsia and intercostal neuralgia may result.

The paralysis of vertebral disease is essentially motor, and always commences as such. Sensory function is last to appear and first to return where improvement takes place, because the motor tracks being anterior bear the brunt of the pressure, while the sensory are posterior and more protected. Owing to sympathetic connections, however, entire control of the bladder and rectum sensations and functions is never entirely lost.

By continuity, or by abscesses opening into the spinal meninges, tuberculous spinal or cerebro-spinal meningitis may be produced, but more frequently the latter arises from general miliary tuberculosis—both rare complications of vertebral tuberculosis.

When spinal abscesses form pus collects in front of the affected vertebræ; upward progress is shut off by the overhanging, displaced vertebræ, and in other directions the anterior ligament, periosteum, and pleura or peritoneum thicken and form an abscess wall so that the pus, to make its way out, must find exit on one or other side of the spine and enter one or both of the sheaths of the psoi muscles, and destroying the contained muscle present in the iliac fossa, groin, or thigh as a psoas abscess, or pass backward through or external to the quadratus lumborum, and give rise to a loin or lumbar abscess.

Cervical spinal abscesses by much the same process point either in the pharynx or find their way along the fasciæ and muscles to some point upon the neck. When cure is established, after deformity has taken place, true or osseous ankylosis of the affected vertebræ takes place, inflammatory products are organized, absorbed, or encysted, the muscles relax their vigil, and the cord becomes accommodated to its altered position. Firm ankylosis is to be desired in any part of the spine. This desideratum usually involves great deformity if much bone destruction has taken place, but is preferable to less deformity with the vertebral bodies separated and held apart by slender bridges of bone which are liable to fracture and dangerous relapse upon slight provocation.

Symptoms are frequently obscure at first and extremely palpable afterward. The appearance of a boss of unnaturally prominent spinous processes may appear without prodromata and constitute the first sign. It is

at this stage that most of the cases amongst the poorer people are brought to the surgeon. Stiffening of the spine and nerve symptoms usually long precede recognizable deformity. Pain will usually attract the person's attention and may be mistaken for colic, muscular cramps, dyspepsia, rheumatism, neuralgia, or "growing pains." It is aggravated by motion or concussion of the spine, as in riding in a carriage, over crossings in a street car, or by missing a step; is always referred to the same locations and is relieved by rest. It is usually complained of as intercostal, substernal, sciatic, or as headache of the occipital distribution when the disease is located in the cervical spine. Some local pain or tenderness may be present, but this is usually dull, whilst the referred pains are apt to be sharp. Before actual pain develops various minor sensations, as tingling, burning, formication and itching, may be present. It may be referred to the hip, which, accompanied with spine lameness or alteration of gait, may cause error in diagnosis. The sensation as of a cord tied tight around the chest or abdomen, and spasmodic abdominal attacks with accompanying or subsequent flatulent distention, are not uncommon symptoms. Pain and muscular tension can usually be relieved at once by longitudinal extension or by bending the spine in a direction contrary to the angle of deformity, as by a hand placed under the back and the patient thereby partially raised. In rare instances, however, they may thus be aggravated. Elevated temperature may be a prominent or an absent feature of the case. When acute it rises to 101° or 102°. If abscesses become infected it may rise higher, and then become of hectic type. A high temperature, except at first, or upon abscess infection, will indicate grave complications. Paralysis or other severe nerve symptoms may occur at any stage, as also may those of spinal inflammation, cerebro-spinal meningitis, general miliary tuberculosis, phthisis, hip disease, empyema, and peritonitis.

At once, or after a lapse of months, or even years, prominence of the spines of the affected vertebræ and angular deformity appear in varying degree. So, also, is it the case with abscesses; they may present early, late, not at all. Anæsthesia may be required for their diagnosis if deeply situated. Very late loss of motion, then sensation, and finally contraction of leg-muscles, bedsores, or amyloid degeneration of viscera may supervene; the muscles waste, and the patient becomes excessively bloodless, pallid, and of aged appearance, even if very young.

Certain special symptoms pertain to atlo-axoid and occipito-atloid disease. There may be spasm of the sterno-mastoid or choreic movements of the neck muscles or neuralgia or paralysis of the brachial plexus, all of which are increased by nodding rather than by rotation, and relieved by occipital extension. Laryngeal cough, or stridor, difficulty in respiration, deglutition, or phonation may be present. Sometimes grating or crepitus can be developed by motion. The head is stiff, thrown forward or to either side, the chin forced upon the sternum, the neck appears shortened, and the spine of the axis is extremely prominent. Rarely the head in addition to being thrown forward is turned upward by spasm of the posterior neck muscles. The head is held in the hands when the disease is extensive; there is danger in any movement; the patient is apprehensive of sudden death and cannot lie down or lean forward. There is constant danger, in extreme cases, of sudden dislocation or fracture, pressure upon the cord and instant death. Abscesses of this region usually point in the pharynx or upon the neck.

Diagnosis.—With this end in view the patient should be stripped naked in a warm room and stood before, or laid across the knees of the surgeon.

All cases wherein there is any possibility that disease of the spine may be present, to account for distant or obscure symptoms, should be thus examined.

Spinal pains can best be elicited by motion of the column and pressure in its axial direction. Percussion, applications of electricity, heat or cold, are most unreliable.

Muscular symptoms are, perhaps, most important. Almost as soon as disease commences the erector-spinæ muscles involuntarily assume the support of the column to prevent movement of, or pressure upon, the diseased part. This gives rise to characteristic postures and modified movements, recognition of which is most to be desired, for treatment instituted at this stage is highly successful and prophylactic.

No skill is required to diagnose later stages when deformity has taken place, nor will treatment then avail for much. The characteristic posture is one of caution and apprehension. The child tires of play, lies about, or seeks support; is easily fatigued. Complains, perhaps, of local or referred pains or other sensations, is clumsy in walking, or struts or shuffles along without elasticity. He is afraid of jarring, does not jump; turns rather than look around, and in every way, quite involuntary, as a rule, at first, saves the spine from motion or concussion. The head is thrown back, the shoulders elevated by the trapezii, the arms hang at the sides, and the toes turn out. All movements are guarded. If asked to pick up an object from the floor he rests a hand upon the corresponding thigh and bends the knees until the free hand reaches the object, or he may kneel outright. He may continually hold his head in his hands, and phonation, respiration, or deglutition may be interfered with if the affection be cervical.

Fig. 263.

Early dorsal vertebral tuberculosis; typical posture in stooping; child cannot bend spine in picking up object, and supports her weight by hand on knee. (Smith.)

Even slight stiffness of the spine can be made evident by the above and other gymnastic performances, which the surgeon's ingenuity will supply.

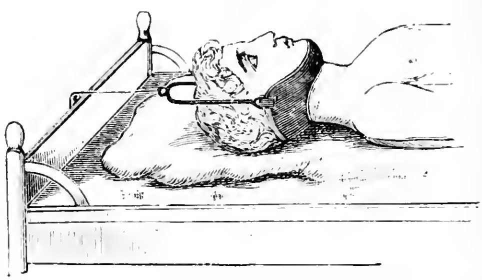
Vertebral tuberculosis must be differentially diagnosed from rheumatism; neuralgia; affections of the cord and membranes, as myelitis, and meningitis; sprains; tuberculosis of the hip; abscess, and other affections of the liver and kidney; perityphlitis, aneurism, and tumors of, or pressing upon, the vertebræ. The last-mentioned diseases may exactly present the usual symptoms of spinal disease, even to the characteristic deformity by pressure absorption of the vertebral bodies, and cannot be positively defined therefrom until late. Happily, these conditions are very uncommon.

Tuberculosis of the vertebral joints may become engrafted upon a spine already affected with lateral curvature, when some symptoms may be

decidedly modified. I concede the possibility, indeed the belief, that other than tuberculous forms of inflammation of the spinal joints and bones take place, but think (as treatment would, in all cases, be identical and so little is known of the other varieties) to prevent confusion by omitting their description.

Treatment is of greatest value in the earlier stages, when the disease may often be entirely checked. The great indications are to build up the vital powers and to secure local rest. The former is to be attained by attention to the hygienic surroundings and diet of the patient, and by the administration of such agents as cod-liver oil, iron, iodide of potassium or mercury, hypophosphites, strychnia, and, perhaps, phosphorus. A little brandy can often be added to the diet with advantage. Removal to sea or country air will usually make marvellous changes for the better. Even if it is necessary for the patient to remain in bed, he should be placed upon a hard hair mattress cot, which can be carried into the yard, to the roof, or to another room. Massage, electricity, and douching must not be neglected. From the first appearance of symptoms until consolidation has well advanced (most certainly while any acute symptoms last) the patient should be kept in bed, and, as much as possible, motionless upon his back. While symptoms are very acute sand-bags may be placed upon each side of his body. Even greater repose can be secured when

Fig. 264.



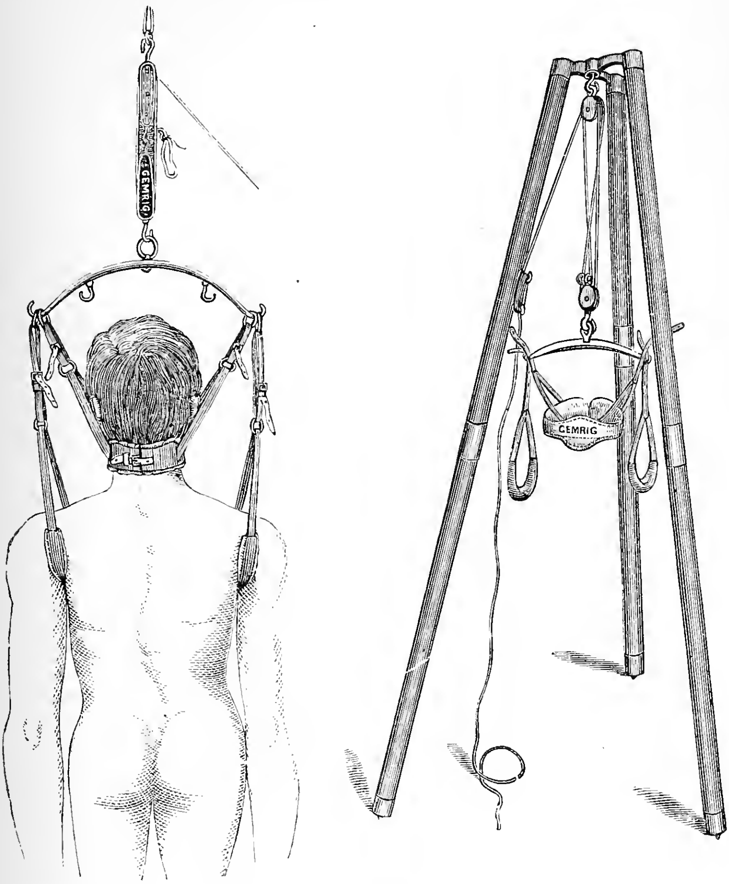
Extension in the recumbent posture. (Wyeth, after Reeves.)

indicated by applying extension to the neck and elevating the head of the bed; by its application to the legs and elevating the foot of the bed, or by the conjoint application of both methods. It is also well to place a small pillow under the angle of deformity, or to sustain that portion of the body in a sort of sling, after the manner of Reeves. I do not wish, however, by this advice to be construed as endorsing methods which tend to correct forcibly the deformity, which, in my opinion, are ill-advised and contrary to the teachings of pathology. Neck extension is especially called for in cervical disease. The object of treatment by posture and moderate extension is to relieve muscle tension, and pressure upon the affected vertebræ; by which are secured consolidation with least deformity, and comfort to the patient meanwhile. Desperate cases, where bedsores are threatened, must be placed upon an air- or water-bed.

When acute symptoms have subsided, the patient may be allowed to get up and go about in a brace. Where limited circumstances prohibit more expensive apparatus, the plaster jacket, while not so light, convenient, or comfortable as other apparatus, yet answers every purpose of treatment.

For its application the patient should be stripped to beneath the hips, or entirely, and a close-fitting woollen shirt, extending below the trochanters and provided with shoulder-straps, put on. He is then raised in a suspension apparatus until he is comfortably resting upon the great toes.

Fig. 265.

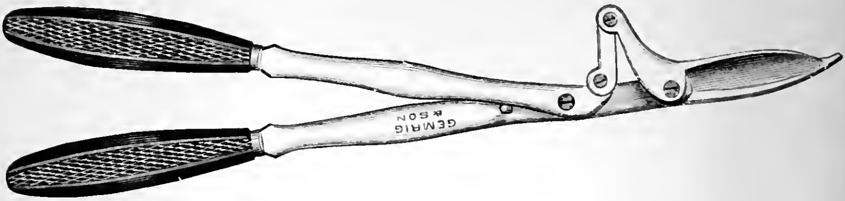


Suspension by means of tripod for application of jacket for spinal disease.

Now, while he grasps the suspension rod with his hands, moistened crinoline bandages, well impregnated with plaster-of-Paris, are evenly wound about the trunk from just below the trochanters to the axillæ. Any inequalities are smoothed over by the hand or a little moist plaster rubbed into them. A folded towel should be placed over the lower abdomen to allow for subsequent distention of the stomach by food, but this can be dispensed with if the patient has recently partaken of a meal. If the patient is a female, that portion of the jacket in the interval between the breasts should be well moulded in before the plaster sets. As soon as the plaster has become firm, it is cut vertically in the median line in front and carefully sprung off. It is then trimmed along the borders with chamois

skin, somewhat padded in the axillæ, and lacing eyelets placed along the cut edges.

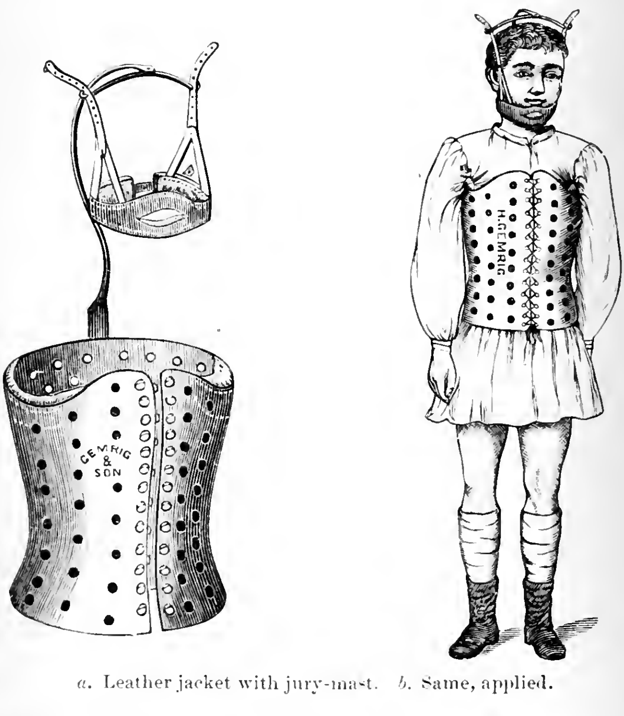
FIG. 266.



Shears for cutting gypsum bandages and jackets.

If the vertebral prominence is sharp or irritable, a ring of wool should be placed about it before the bandages are applied, or a fenestrum may be cut in the jacket and its edges padded. Or, when even this much cannot be afforded, jackets may be applied every few weeks and allowed to remain uncut until it is time to apply a new one; but, in so doing, great care must be observed in young children to see that pressure sores do not

a FIG. 267. *b*

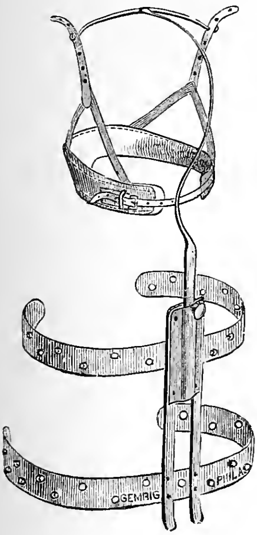


a. Leather jacket with jury-mast. *b*. Same, applied.

develop and that vermin do not find lodgement. Where circumstances permit, it is much preferable to use the plaster jacket simply as a mould in which is cast a plaster model of the body, around which is accurately fitted a leather or felt jacket, which is subsequently trimmed, fitted with eyelets, and extensively perforated.

The above will answer perfectly for all diseases located below the upper dorsal region. Otherwise a supporting head-gear must be fitted to the jacket. This is done by either fastening the head-piece between the folds of bandages or by subsequently riveting it upon the completed brace.

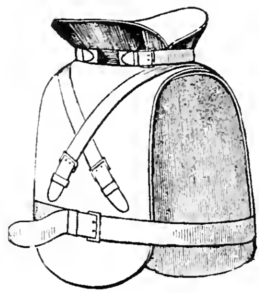
Fig. 268.



Head support for spinal tuberculosis.

For disease of the cervical spine and of the occipito-atloid region, the "jury-mast" head-gear will not always afford sufficient security. Then some such device as the leather collar is more appropriate, and the jacket is dispensed with, but such cases had best remain in bed until firm ankylosis has taken place. Removable jackets need not be worn in bed. If the spine straightens out, or if the proportions of

Fig. 269.



Breast-plate and collar for cervical or high dorsal caries. (Owen.)

the patient materially change, a new apparatus must be, in the same manner, applied. Nothing but the shirt, or shirt and chemise, must be worn beneath the jacket, and it is well for each patient to have a suspension apparatus and put on his brace while the spine is extended. If the child is continually kept in the admirable suspension chair of Dr. Meigs-Case when out of bed, no jacket will be required.

Operations intended to remove the diseased portions of the diseased vertebræ, or to afford direct drainage, have been performed, but enough is not yet known of these measures to justify either criticism or endorsement.

Treatment of Abscesses.—Whenever a palpable abscess is accompanied with pain, fever, or other marked local or constitutional signs, it should be opened forthwith. But if it do not incommode the patient, it need not be interfered with until it shows some tendency to point or open. Abscesses should never be allowed to open spontaneously,

Fig. 270.

Suspension chair of Dr. Meigs-Case

for fear of infection. Such infection usually gives tenfold impetus to the disease, and may cause speedy death by suppurative exhaustion. In opening abscesses, absolute antiseptic precautions should be taken. Free incision is made, the sac washed out with 1 : 1000 bichloride solution, freely curetted as far as possible, again washed out and the incision sutured, leaving in a large drain. A large dressing should then be applied and renewed, and the sac re-washed upon the slightest indication therefor. Thus treated, their opening causes none but beneficial results.

Psoas abscesses, if detected in time, can be more easily dealt with by cutting down upon the sac above Poupart's ligament.

Prognosis.—Tubercular spondylitis is rarely fatal under ordinary circumstances. Prognosis depends upon the age of the patient, the duration and location of the disease, and whether abscesses have formed or have become infected. High cervical disease is always dangerous, occasionally suddenly fatal.

Tuberculosis of the Sacro-iliac Articulation.

This seat of tuberculosis is not uncommon, and often, especially during early stages, is confounded with sciatica and hip-joint disease. It occurs rarely in children ; between the ages of fifteen and thirty-five it is most common. The causes are either local traumata or extension from the acetabulum or from iliac or hip-joint abscesses burrowing into the articulation.

The symptoms are pain, local and radiating, tenderness upon pressure or motion, especially when pressure is made upon the iliac crests, perhaps interference with or painful defecation or urination, and, rarely, œdema of the corresponding limb from swelling pressure upon the iliac vein. The body is inclined to the sound side to secure absence of pressure, and extension by weight of the sound limb. Swelling occurs early, but does not shift from over the line of articulation or obliterate the gluteal fold, but later, especially when abscess forms, the tumefaction may extend to and change the buttock contour. Always there is wasting of the gluteal muscles and loss of power in the limb. Apparent lengthening of the limb is due to dropping the pelvis to secure ease; the foot is everted. Abscess may subsequently form and point locally, or discharge into the pelvis or its contained organs, through the sciatic foramen into the buttock, via the levator ani and obturator fascia into the ischio-rectal fossa, or upon the inside aspect of the thigh.

The affection must be differentiated from spinal or innominate caries, hip disease, and sciatica.

Treatment of the early stages should comprise strict rest, extension, proper diet; plus blisters, cautery, or iodine paintings locally. Later, if all goes well, a hip case or splint, or crutches may be allowed. If by these means progress of the disease is not quickly arrested, and more particularly if abscess supervene, the joint must at once be laid open by incision of its own direction and length, and the diseased portions of the membrane or bone scraped or chiselled away. Following this the wound should be kept well packed with antiseptic materials until it heals. Often all that we can do will not prevent the patient finally dying from exhaustion.

Tuberculosis of Hip-joint.

Tuberculosis of the hip-joint is a disease very frequently met with. Two-thirds of all cases are under sixteen years of age; males are most often affected. It may attack one hip or both either synchronously or at different times.

Causes are, in order of frequency: injury, spontaneous, and auto-infection from other organs or tissues.

Pathology.—The inflammation may begin as a tubercular epiphysitis of the head of the femur, and, the epiphyseal junction being entirely within the joint-capsule, thence quickly spread to the other articular structures. Or it may take onset upon the acetabulum floor in the lines of union of the three segments of the ilium; in the synovial membrane; or, possibly, in the ligamentum teres. But most usually the disorder is supposed to originate in the osteo-cartilaginous junction of the femoral head.

According to the constitution of the patient the case will run either an acute or chronic course. If acute, profuse suppuration and breaking down of the contents of the joint and necrosis of the neighboring bones take place. Or, if epiphysitis has taken place, the head of the femur may become entirely detached into the joint. The worst forms are those where the tuberculous process is transmitted along the bone shafts, through the bottom of the cotyloid cavity into the pelvic bones or their neighboring organs, or into the blood current as miliary tuberculosis.

In the chronic variety, on the other hand, the disease is persistent; pus is not formed, or only slowly, the effused materials are plastic, become firm and, in time, give rise to fibrous, rarely osseous, ankylosis.

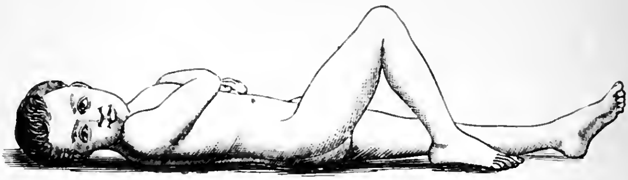
In either case, but especially the former, destruction of the joint plus continuous muscular action may dislocate the altered head or neck of the femur upon the dorsum ilii and give rise to great deformity.

Symptoms.—Often before positive symptoms develop, the child is noticed to exhibit lassitude, to tire easily of play, become pallid, sleep uneasily, lose strength, and, perhaps, be feverish. He eases the affected limb in exercise, play or standing, and, possibly, may complain of what are vulgarly taken for "growing pains" in the knee, thigh, or hip. Great attention should be paid to these conditions, as diagnosis at this stage is of vital importance. Yet, no one sign can be depended upon more than to centre attention upon the parts, and, perhaps, indicate precautionary treatment until others develop.

Stiffening will be the first positive symptom and give rise to lameness and a characteristic standing posture, where, leaning a little forward, all weight is thrown upon the sound limb, while the other is advanced, slightly flexed, abducted, and rotated outward. Stiffening of the joint in varying degrees of flexion, at first by muscle tension to prevent motion, and later by joint changes, is present in all stages of the disease. Even in the slightest amount it can be recognized by placing the child flat upon a table, and upon attempting to straighten out the affected leg, the vertebræ become arched forward by tension upon the psoas and iliac muscles and the hand can readily be carried beneath. When the sound limb, which, to gain the confidence of the child, should first be examined, is so manipulated, no change in the back takes place. This involuntary muscular tension, which is shared in by all the anterior muscles of the thigh, is to protect the joint from motion and consequent production of pain. The degrees of flexion, abduction, and rotation, indicate that position of the joint which gives most room to accommodate the effusion always present

in the joint; later, flexion may depend upon excessive muscle contraction. Impaired motion of the joint is amongst the most valuable of early signs. If motion is unimpaired, it is almost conclusive evidence that no hip disease is present. Interference with extension and flexion may be

Fig. 271.



Test for fixation of hip-joint—position of leg when spine is straight. (Smith.)

Fig. 272.

Curvature of spine when leg is extended. (Smith.)

caused by spinal disease, but rotation (the crucial test) is only impeded by hip-joint involvement. To apply the test, flex the thigh to an angle of 120 degrees and then attempt rotation.

All manipulations should be most gentle, cause little or no pain, and, except to diagnose very late complications, anæsthesia should never be employed, as it will relax all muscles and thus defeat our object.

Pain, while usually present in some degree locally, yet is most complained of about the knee, over the patella, or upon the inner side of the thigh. Especially is it referred to these parts when the disease is located in the femoral head. The mechanism of this referred pain is not clearly understood, but, undoubtedly, the proximity of branches of the obturator distribution in part explains it. There are no referred pains at first, when the process primarily involves the synovial membrane, but local pain from capsule tension is severe and constant. When the capsule is tense there is much tenderness in the groin and above the great trochanter. Sudden ceasing of long-continued severe pain indicates that the capsule has given away and the fluid joint contents have escaped into the surrounding tissues. Night starting and sudden cryings out (ostitic cry) during sleep or waking moments are common, being due to the muscles having, during sleep, relaxed their vigil only to assume rigidity again suddenly and painfully as the child awakens. Pain, both locally and referred, is increased by inward pressure upon the great trochanter. Pounding the heel or flexed knee is a very crude and valueless method of developing hip tenderness. Patients suffering acutely from hip-joint distention occasionally can gain more relaxation of capsule and quietude, hence comfort, by crossing the knee over the sound thigh or by hugging it upon the abdomen or chest.

Swelling is early and most noticeably developed in the synovial variety.

Great heat and redness do not, as a rule, accompany it, except in acute tuberculous abscesses of the joint or surroundings, but more or less local rise of temperature is present. Swelling is most apparent in the groin, where the inguinal glands will be very prominent, about the great trochanter, and, in a minor degree, in the buttock, and about the joint generally.

Muscular Wasting or Atrophy early sets in and involves the joint surroundings and the entire limb. The proportions (even length, as the bones participate) of an affected limb will never again equal those of its fellow. Comparative measurements of the calves and thighs will demonstrate the presence and amount of atrophy. Wasting of the gluteal muscles, together with the swelling in that region, flattens and broadens the buttock, shallows or obliterates the natural crease or fold and creates a deviation of the internatal line toward the sound side. To observe gluteal changes the patient is stood naked on a table, his back to the surgeon.

Fig. 273.

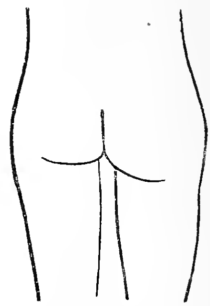


Diagram showing flattening of buttock and lowered position of gluteal crease on diseased side.

Compensating Postures.—Continued hip disease from muscular tension in time gives rise to a lateral curvature of the lumbar spine and compensating curve in the dorsal region. This, with abduction of the thigh, makes the leg appear lengthened. But until great bony destruction, or actual dislocation of the joint occurs, changes in length of the limbs do not occur, except rarely, when great distention of the capsule forces the femur away from the acetabulum and produces moderate lengthening. Careful measurements of the position of the trochanter will prove its position to be unchanged in most cases. Apparent changes in the length of the limb are simply the result of compensatory postures, which permit locomotion without motion of the affected joint.

Deformity, up to the later stages, is purely muscular. But when the capsular and other ligaments are destroyed, and especially when, in addition, the head of the femur has been shed into the joint, or both head, neck, and the margins of the cotyloid cavity have been eaten away, dislocation of the femur upon the dorsum ilii is very apt to take place through influence of continued muscular action. Pain then ceases and the limb becomes, from spasm or inflammation of the adductor muscles, adducted and inverted. When both hip joints become thus dislocated the legs are crossed in adduction, and produce what is called "scissor leg" deformity. Dislocation is determined by the position of the trochanter, characteristic deformity, and actual shortening. Accidental force applied in the length of the limb may drive the femoral head or neck through the floor of the acetabulum if the latter is much diseased and eroded. Occasionally it becomes entirely destroyed, and the femur slips into the pelvic cavity without aid of outside force.

Abscess is a very frequent, generally inevitable, symptom and complication. Neglected cases almost invariably suppurate. It may, or may not, produce constitutional disturbance unless septic infection take place, when hectic and some degree of exhaustion are certain to follow. Abscesses may slowly develop and be circumscribed by the capsule. Or it may supervene with rapidity and give rise to great suffering until the capsule ulcerates or ruptures. Then the abscess contents escape into sur-

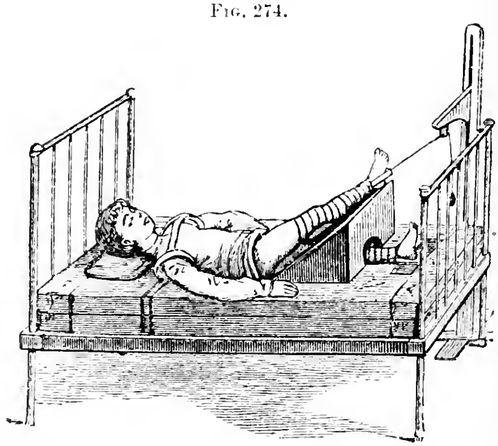
rounding structures and, perhaps, give rise to multiple foci of suppuration or a diffused abscess. In either case the pus, earlier or later, finds its way to the surface. It is supposed that certain abscesses may form in the inflamed joint surroundings without rupture of the capsule. Abscesses which point below Poupart's ligament are most common and come directly from the joint. Those which appear above that ligament find their way through the acetabular floor into the pelvis, and thence to the surface, or into the rectum, bladder, or intestines. Either variety, however, may point in the gluteal or ischio-rectal regions. The latter must not be mistaken for simple ischio-rectal abscess or fistula.

Diagnosis.—By application of the above given diagnostic signs of hip tuberculosis, and of those of the respective diseases which follow, it may be distinguished from rheumatism, spinal or sacro-iliac disease, psoas or iliac abscess, periostitis of the upper femur, simple extra-articular abscess, spastic paralysis, and injuries or displacements of the femur.

Treatment should be begun when disease is but suspected, and before unequivocal signs are present. The fundamental principles of treatment are: to build up the general health by such measures as have elsewhere been indicated, and to secure absolute rest for the joint until all acute symptoms have vanished. Great deformity and suppuration will occur unless treatment is thorough and early.

To secure the necessary repose, the patient must be kept strictly upon his back in bed, with pulley extension and lateral sand-bags. He must not be allowed to sit up in bed. If necessary, a sheet across the chest or

Fig. 274.



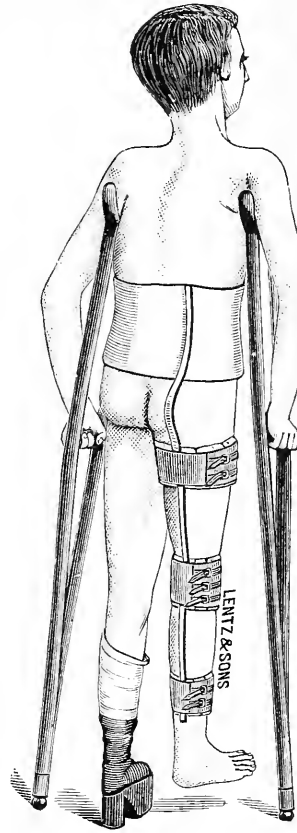
Extension of the limb in a flexed and adducted position. (Marsh.)

under the arm-pits, and tied to the sides or head of the bed, must be employed. If extension with the limb flat upon the bed produces pain or spine-aching, then the direction must be in the line of the flexion over a wedge-shaped pillow. Extension in the usual manner, in these latter cases, produces great intra-articular pressure by dragging upon the psoas and iliacus muscles, which act as the fulcrum of a lever.

After this extension at the angle of deformity has been kept up some time the limb can, from day to day, without pain or resistance, be brought to better position and, finally, into the axis of the body. During extension the foot must be supported laterally and vertically to prevent

consecutive deformity; to the same end and to prevent atrophy, massage of the limb, without motion of the joint, should be employed. A cradle to hold the bedclothes from the limb is also desirable. Counter-irritation about the hip by blisters is of value in acute stages, and will often relieve pain. Excessive pain from joint distention can be at once stopped by aspirating the joint. The needle should be introduced through the gluteal, not the inguinal region, becaue of proximity of vessels in the latter locality. Pain can often be moderated by simple change of position, or of the direction of extension.

Fig. 275.



Thomas' hip splint.

Extension, as above described, must be kept up, perhaps for many months, until all acute symptoms have vanished and the thigh is in the body axis. Then the patient may gradually be allowed to get up, but must constantly wear a Thomas's, or other immobilizing apparatus, and still sleep with the extension apparatus applied.

The removable extension apparatus of Morton (Fig. 276) is the most convenient for the latter purpose. When the disease has still further progressed toward cure, night extension may be omitted; and when motion has become normal, or when consolidation of the hip is complete, the splint can be tentatively left off. Six to ten weeks will be consumed in the cure of even the most favorable cases. Non-use of the joint, alone, will never produce stiffening which cannot afterward be readily overcome.

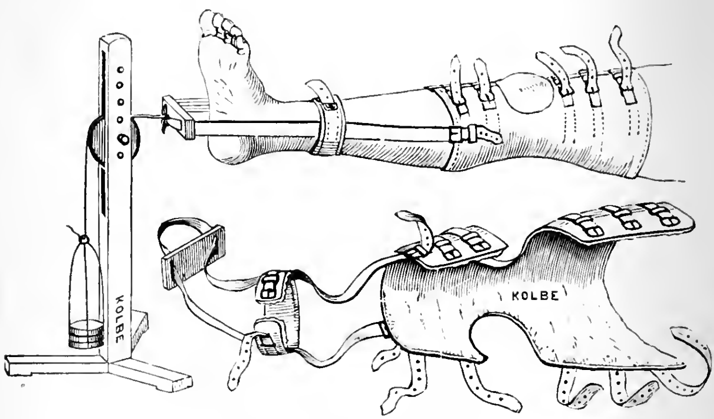
Late stages of the disease may also demand extension or splints to prevent or reduce the shortening, dislocation, or other deformity. Forcible reduction of deformity is not justifiable at any stage, nor should tendons or muscles be divided except in old cases where they impede function or have become hopelessly contracted.

Abscesses need not be interfered with unless they produce pain or constitutional disturbance, or show tendency to open spontaneously. Then they should be freely incised, curetted, irrigated, drained, sutured, and protected from septic infection by proper dressings. Abscesses which open themselves, or are surgically infected, at once set up hectic, and are very apt to lead to such changes in or about the joint as to necessitate subsequent excision or amputation. Abscesses which open above Poupart's ligament, or into the pelvic contents, are almost hopeless affairs, as they indicate pelvic bone involvement, which is practically unamenable to known treatment.

Exhaustion from continued suppuration may demand excision of the head of the femur and extirpation of the joint and infected surroundings. This may effect cure if all, or almost all, disease can be eradicated.

Otherwise, the patient will probably succumb to the effects of prolonged suppuration, or die of systemic tubercular complications. In suppurating cases, consolidation (usually inseparable from great deformity) is all that we can hope for; under the circumstances even that result must be considered good, though years may be consumed in its attainment. If the disease has travelled along the shaft of the femur, or osteomyelitis has developed, amputation will be the patient's only chance for life. If the joint has become ankylosed in an awkward position, no treatment for its correction should be undertaken until the last traces of disease have long since disappeared. Then one of several operations may be employed:

Fig. 276.



Morton's extension apparatus.

The neck of the femur may be divided by introducing an Adams saw through a small incision immediately above the great trochanter and carried down until the neck is touched. After division of the bone and any resisting muscles or fascia, the extremity is brought into the axis of the body, and either in that position treated as a fracture of the same region, or, as soon as the wound has firmly healed, at once starting active and passive movements that a false joint may be established. Very fair position and function result from the latter procedure, or, if dislocation does not exist, the osseous material interposed between the acetabulum and femur may be divided similarly. A chisel should never be used for these purposes on account of the inevitable traumatism and splintering which are thereby produced. Excision of the head of the femur and division of resisting structures will also give equally good position, but with greater shortening and more uncertain function.

Dislocations resulting from hip disease can never be permanently reduced. Attempts thereat are very dangerous, and should not be considered.

When a patient does not rally under treatment, but continues to lose ground, and especially when from continued suppuration, excision of the joint is clearly indicated; but, as operation in these stages is excessively dangerous, the chances of life with or without surgical interference must be most carefully balanced. Whenever large sequestræ or the separated femoral head can, by probe or finger, be felt, they should be removed by incision and the surroundings within reach curetted and washed out as thoroughly as possible.

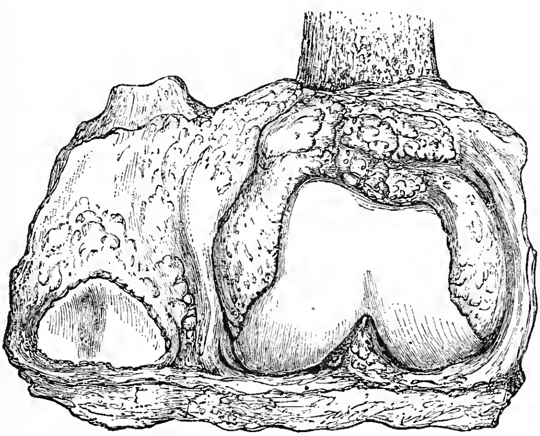
Prognosis.—Even in cases cured with good function some atrophy and consequent shortening will remain and the limb will never quite catch up to the other. Interference with the upper epiphysis makes this more marked. Cure with stiffening and deformity should be considered a good result in more advanced cases. The joint may suppurate, apparently hopelessly, for even years and then consolidate. It is never safe to say that any case cannot recover without operation. Amputation can sometimes be done with comparative safety when the risks of excision would be too great. Excision is often necessary in advanced stages. Months and years are often necessary to cure completely a well-marked case; eighteen months may be called the average duration of disease. Relapses are frequent, particularly should the patient be subjected to exhaustive conditions, or bad diet or hygiene. Other joints may become involved. Many cases succumb to intercurrent tuberculosis or other complications. Prognosis should always be most guarded.

Syphilitic Arthritis.

Syphilitic arthritis is a frequently overlooked disease, which is almost limited to adults suffering from tertiary syphilis, but may be developed in congenitally syphilitic children.

During the later manifestations of syphilis the deep layers of the synovial membrane of one or more joints becomes infiltrated and swollen. This thickening extends to the sub- and superjacent structures, usually taking the form of innumerable vari-sized gummata. The endothelial layers of the synovial membrane are never primarily involved, but are

Fig. 277.



Syphilitic arthritis of the knee-joint, showing thickened sub-synovial tissue and inflamed bone. (Marsh.)

bulged into the joint cavity by the new growths pressing from beneath. Effusion, if present, is always slight. The disease in its earlier stages much resembles other subacute affections of like situations. When gummata have developed, however, the diagnosis is evident, for they can often be felt, which, with the general spongy feeling of the joint, symmetry of the

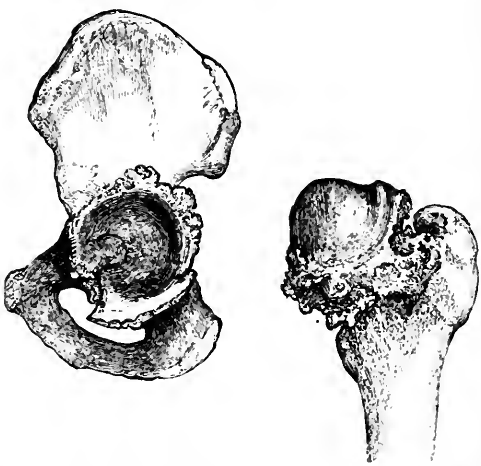
joint involvement, perhaps slight pain, creaking, and effusion, makes the real nature of the case plain. Extension, rest, counter-irritants, and anti-syphilitic remedies embrace the necessary treatment, to all of which, however, the disease will often prove most obdurate. Firm, fibrous adhesions may remain after absorption of the gummata and more or less cripple the articulation, or, more rarely, the nodules may soften, suppurate, and discharge into the joint cavity, giving rise to purulent arthritis.

Syphilitic arthritis also as frequently invades a joint from the bone ends. Specific arthritis enlarges the bone extremities, giving rise to all the symptoms of syphilitic ostitis elsewhere, and the joint is speedily involved in suppurative destruction, which proves rebellious to all save heroic surgical measures such as excision, or even amputation.

Osteo-arthritis (Arthritis Deformans).

Osteo-arthritis is a form of chronic arthritis which is almost limited to later life, being disposed to by constitutional depravity and excited by diseased conditions of the proximal bone-ends or synovial membranes, and traumata.

FIG. 278.



Changes in hip-joint dependent upon osteo-arthritis. (MARSH.)

The disease commences in the articular cartilages, which rapidly lose their smoothness and pearly color, become of a yellowish tint, and wear away at the points of pressure contact, even into the cancellated structure of the subjacent bones, whilst at places, such as ligament and muscle attachments, where no pressure is brought to bear, cartilage hypertrophy and thickening occur and give to the joint a characteristic deformed appearance. One or more of these nodules may subsequently become isolated and become "loose bodies" in the joint. Later the synovial membrane becomes thickened and exceedingly vascular. At this stage effusion may appear, but is not inevitable: marked distention is always transitory; occasionally slight effusion may last throughout, but as often it will entirely disappear. Now the cartilaginous outgrowths

begin to ossify, and from the wearing down of the bone the joint surface becomes broad and at the same time extremely mobile by the consequent relaxation of the surrounding ligaments and other tissues, which themselves at this stage have become softened, atrophied, or even destroyed. Displacements of the bones composing the joint usually, at this stage, takes place, and great deformity results. Such displacements constitute a variety of so-called "pathological dislocations," and are due to the continual activity or spastic contraction of the neighboring muscles after the joint structures have been so weakened as not to be able to resist their displacing action. Ankylosis in any position may finally end the alterative process.

The first symptoms of osteo-arthritis are dull, aching pains in the joints shortly followed by pain and creaking upon motion. Subsequent symptoms depend greatly upon the rapidity with which the particular case may progress. The disease may run its full course in a few months or continue indefinitely. Frequently it has had origin in some form of injury, and without the exercise of great care in diagnosis deformities produced by the arthritis may readily be mistaken for neglected fracture, dislocations, or other injuries. Treatment of this form of arthritis, unfortunately, will almost always prove unavailing. Those measures which are best calculated to improve the general physical condition are always to be applied, together with massage, hot and cold douches, and perhaps counter-irritation locally. Excessive deformity can usually be prevented by splints, extension, plaster bandages, and division of tendons.

Atrophic Arthritis (Charcot's Disease).

Atrophic arthritis is a retrograde arthropathy which may develop in the later stages of locomotor ataxia. Etiologically, it is directly dependent upon those changes in the central nervous system which are present in ataxia, and most likely due to interference with trophic nerves. In its early manifestations the disease much resembles osteo-arthritis, but later runs a very distinctive course. The presence of a group of ataxic symptoms would always settle the diagnosis in favor of atrophic arthritis.

Beginning in any joint or number of joints, but usually in the knee, the synovial membrane is thickened, and some effusion is poured out; grating with some pain and disability supervene and ostitic thickenings begin to form. Later, pain almost disappears, great absorption of contact points of the bones takes place, and wide separation of articulating surfaces with great resultant deformity occurs. The ligaments have by this time become greatly stretched and disintegrated; but a most surprising and diagnostic symptom is the preservation of more or less locomotive function of the joint until a very late stage of the disease. Ostitic formations are much less marked in atrophic arthritis than in osteo-arthritis, but erosion of the bones is markedly greater in the former.

Months and years are usually required for the joint symptoms of ataxia to run their course, but occasionally instances are met with where but a few months are necessary to carry the process to its utmost limit. No special local treatment can be recommended; our efforts should be toward removal of the cause.

Hysterical and Neuralgic Joint Affections.

These may be classed together, as both are purely subjective disorders. Though not identical they are frequently exceeding difficult to differentiate. Females more often than males are affected. In the hysteroid affection pain may be complained of out of all proportion to other symptoms, perhaps combined with voluntary or involuntary fixation. Slight swelling of the joint may supervene, owing to increased vascular tension thereabout, but more often the peculiar avascular condition of hysteria will render the joint pale and bloodless.

Hyperæsthesia, either local or general, will be present; pain may be definitely located or shift its position.

The joint can always be freely moved under ether, often also when the patient's attention is diverted or under application of extension when long continued; false ankylosis and muscular wasting may take place. Symptoms are mostly anomalous, varying, and inconsistent, and apt to be but a single group in an hysterical aggregate.

Great caution must be observed, and close watching and repeated examinations resorted to before positive opinion of these cases is expressed.

Treatment of these neurotic joint affections should include special attention to the general health as well as the judicious use of massage, electricity, anti-neuralgics, and anti-periodics; possibly counter-irritation, prolonged extension, and occasional movements under anæsthesia.

Ankylosis.

By ankylosis is meant that condition of a joint free from active disease in which motion has become restricted or abolished.

When all motion is impossible ankylosis is complete; when partial motion remains or can be developed, incomplete.

Ankylosis may be true or false; true when the bones of the articulation have grown together by cancellated bone structure; and false when the joint is impeded by fibrous adhesions, situated within or surrounding its capsule. True ankylosis or osseous consolidation is also called synostosis. The condition is not in itself a disease, but is the result of preëxistent disease, and the term ankylosis should not be applied to the usual coincident stiffness of inflammation.

In true ankylosis the joint as a joint is destroyed, the cartilages have disappeared over more or less of its area and the cancellated tissue of bone ends has grown together. True ankylosis, therefore, cannot take place until cartilage and its subjacent bone layer have been destroyed upon the surface of the joint. This may be accomplished by disease or by the surgeon, as in the complete bony ankylosis which follows a successful excision of the knee.

The uniting bony substance may be extra- as well as intra-capsular, but the extra-capsular portion is usually nothing more than a calcification of ligaments or other surroundings, which is common to either variety. The joint cavity is generally totally obliterated before any bony union takes place. The true variety of stiffening always is caused by either fractures or long-continued destructive inflammatory disorder.

False or fibrous complete ankylosis may be due to either of the above causes, to trophic changes, to organization of tuberculous or other disease products, or to non-use of the articulation for a long period of time

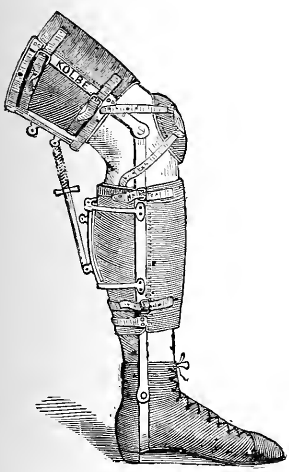
after injury or disease. The greater proportion of all joint restriction results from injury, when insertions of tendons are stretched or torn, the capsule lacerated, and blood or lymph effused. These products subsequently organize and bind folds of the capsule as well as surrounding parts together and motion becomes impeded and painful or impossible. Fibrous bands may also form connecting the joint surfaces. If these adhesions are not early interfered with they will firmly organize and contract or may even become calcareous. But again ankylosis of the false variety may be complete and yet every structure of the joint remain almost unchanged, all adhesions being extra-articular.

Impeded joint-motion from outside cause, such as muscular spasm, hysteria, burns, cicatrices, etc., is termed "spurious ankylosis," but may result in false ankylosis through contraction of and wasting of the joint-structures from long-continued inactivity. Nerve injury also may thus give rise to spurious ankylosis, especially when small joints are concerned.

Diagnosis of the variety of ankylosis can usually be made from the history of the case, but sometimes differentiation will be found impossible. Except in trivial cases, all manipulations should be made with anæsthesia. If the slightest motion remains the case is not one of bony consolidation. If judicious force under ether fails to produce movement, the case had better be considered one of bone variety rather than subject the part to dangerous manipulation, for with such firm adhesion the exact diagnosis would be of little aid in treatment.

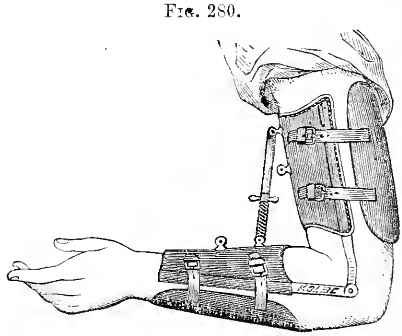
Treatment of ankylosis is extremely important and successful if properly apprehended and applied. It should always be instituted as early as possible, but never while the slightest heat or redness of the part persists, but a moderate degree of swelling may be ignored. Manipulation is of what treatment mainly consists. If this is productive of pain (and it practically always is) nitrous oxide or ether anæsthesia should first be induced. No great force is ever justifiable, nor should a known case of true ankylosis ever be subjected to manipulation. If, with moderate force, adhesions are felt to break, the joint should gradually and gently be put through its range of motions, but manipula-

Fig. 279.



Modified Stromeyer splint for ankylosis of knee.

Fig. 280.



Modified Stromeyer splint for ankylosis of elbow.

tion should never be kept up more than five or ten minutes at one sitting. If it requires considerable force and the adhesions seem very tough and

strong, the outlook is not favorable, and after a few unsuccessful *seances* this form of treatment should be abandoned, as also should it be given up if after each manipulation there is a return of inflammation. This latter complication, however, is liable to follow once or twice in any case and should be prohibitory only when frequently repeated or severe. When it does occur, no further manipulation should be attempted until the parts are again free from abnormal heat.

Certain varieties of stiffness can be manipulated every day or two, others may require a longer interval. Between times motion may be preserved by means of extension, splints, or the Stromeyer screw. (Figs. 279, 280.) Movements should be kept up until the joint regains its former motions, or until no further improvement can, by this means, be obtained. Without securing motion, a fibrous ankylosis at an inconvenient angle may, by manipulation, be changed to one of more comfort or utility. Where tendons have contracted, or are in unrelieved spasm, they should be divided as a preliminary to passive motion; their division alone will accomplish little or nothing.

When a joint has been extensively diseased, as in tuberculosis, manipulation is useless and dangerous, but where adhesions are recent it is most successful, and especially so when the trouble is mainly resident in the peri-articular structures.

Where fibrous ankylosis has become very resistant and firm, nothing except the knife or chisel should be used to separate the adhesions.

Bony ankylosis, if it is thought expedient or necessary, may likewise be treated by driving a chisel or saw through the line of union if the connecting and surrounding tissues are healthy; otherwise, or when there is great displacement or deformity, excision of the joint or osteotomy of one or the other, or both of the proximate bone shafts would be preferable; more especially at the elbow, knee, and hip.

Recurring ankylosis, if troublesome, may demand either division of tendons or excision of the joint. Many cases will require a brace for some time after practical recovery, plus, perhaps, extension at night. (See Osteotomy; Excision of Joints.)

Loose Bodies in Joints.

These are not of uncommon occurrence, and consist of entirely loose or pediculated masses of varying size, which only demand attention when they impede function or cause pain. They arise from: 1, condensed fibrous exudate; 2, organized blood-clot; 3, broken osteophytes, as in osteo-arthritis; 4, actual foreign bodies, as bullets or needles, either encrusted or not; 5, pieces of articular cartilages, with, perhaps, sub-adjacent bone, broken off or exfoliated into the joint cavity; 6, hypertrophied and hardened portions of the synovial membrane; 7, irritative development of cartilaginous cells embedded in the deep layers of synovial membrane.

Fig. 281.

Trochlea of humerus, showing formation and connection of loose bodies developing from synovial membrane. (Miller.)

The first four classes are never pediculated; the last three frequently are; the seventh is always so at first. In the

latter class, owing to severe irritation, one or more of the depots of inactive cartilage cells, which are to be found studding the deep layers of articular cartilages, take on active growth, press forward the layers of membrane between them and the joint cavity, and become prominent as minute nodules. Combined growth and the movements of the joint soon stretch their attachments and they become pediculated, which connection is apt to be snapped during some motion of the joint, and the now unattached bodies float free.

Loose bodies almost never are found in other than hinge joints, and nearly always in the knee. They may be single or in great numbers, according to their mode of origin.

SYMPTOMS arise when the bodies get caught between articulating surfaces. Commonly they become so caught for a second, and at once slip out again. In either case the symptoms only vary in degree and duration. When the accident takes place the joint surfaces are forced apart and bruised or scratched, and the ligaments are put upon a severe stretch, the joint locks, and if it be the knee, the person is thrown to the ground in great agony, sick and faint. If the body slips out again, pain and other symptoms instantly cease, until the accident again takes place. Otherwise symptoms persist until relieved by the surgeon. Very rarely, a joint becomes locked in this way without pain. Any variety may be followed by synovitis, but this is not common or serious except in joints already diseased or predisposed thereto. Frequently recurring entanglement is apt, in time, to originate chronic synovitis with persistent effusion.

Bodies can usually be felt beneath the joint covering, more or less definitely fixed in position; but sometimes cannot be felt, or disappear from touch for a time, or upon motion of the joint, and reappear either erratically or upon certain motion or manipulation—as a rule, best understood by the patient himself, as, indeed, is often the best method of unlocking the joint.

Contrary to the case where dislocation of joint cartilages, such as the semi-lunar, has taken place, loose bodies usually lock the articulation in anomalous positions. The history, method of occurrence, and, perhaps, palpable presence of the loose body, will furnish enough evidence for differential diagnosis.

Such manipulation as each individual case, or the patient himself, may suggest, will unlock most joints. If this fail, nothing short of exploring the joint and removing the offending body will avail. Often wearing a brace or pad will prevent frequent joint-locking by securing the body in one position, or by restricting certain movements of the joint which invite the body between articulating surfaces.

If the distress therefrom becomes great, the bodies should be removed by incision. To do this it should be firmly secured before anæsthesia by pressure of a finger or strap, or better, by transfixion with an aseptic pin or needle. If this precaution is not taken, the body will often have disappeared beyond reach into the joint when the incision is made over its former site. If the bodies are numerous, or cannot be brought near the surface, nothing short of exploration of the joint and the removal of all present in or around it will avail.

INJURIES OF JOINTS.

Contusions of joints call for no other treatment than rest and evaporating lotions. Succeeding complications, such as inflammation or abscess, are to be treated as elsewhere described.

Sprains.—Contusing injuries usually accompany or complicate *sprains*, which may be defined as a condition of more or less stretching, bruising, or laceration of the contents or immediate surroundings of a joint, and are always the result of forcible motion of an articulation beyond its range of function, or in a direction contrary thereto; in fact, sprains are mild varieties of dislocations. The causative force may act directly or indirectly. The hinge-joints are those usually affected. In the milder forms the surrounding ligaments or tendon insertions may be simply stretched, and a few vessels of, or the synovial membrane itself, be lacerated. This is followed by an intense hyperæmia of the entire joint and surroundings, especially of the subserous vessels of the synovial membrane, which often leads on to synovitis; rarely to the suppurative form and to arthritis, unless the subject is tuberculous. Swelling and œdema quickly set in and effusion rapidly distends the joint cavity. This exudate may become plastic and even involve surrounding ligaments and tendon sheaths. Hemorrhage into the joint may take place.

SYMPTOMS.—The injury is accompanied with intense sickening pain, perhaps vomiting and shock, and more or less disability, according to the extent of injury. The joint almost immediately swells and becomes hot, and soon begins to throb with dull pain. The limb will be found in that position which permits least tension in the joint. Motion is exceedingly painful, and if ligaments are extensively torn, is anomalous. If diagnosis cannot be readily made without much manipulation, anæsthesia should be induced. Differential diagnosis from fracture, even under ether, is often difficult; sometimes, as at the wrist and ankle joints, impossible. Wherever this doubt exists the case should be treated as for fracture. Strict adhesion to this rule will save many an unfortunate result.

TREATMENT.—The case seen early—within an hour or two—and diagnosis established, a sprained joint should be plunged into either very cold or very hot water, and there allowed to remain twenty or thirty minutes, until the bloodvessels about it have thoroughly contracted. Swelling, effusion, and inflammation are thus prevented. It is then elevated and firmly bandaged from below upward. The extremity is to be kept thus bandaged and elevated for twenty-four hours, when a plaster or other snug-fitting dressing should be applied, and he may then be allowed to sit up. The cast is to be renewed as swelling goes down, and left on from one to three weeks, according to the extent of the injury. Passive motion and counter-irritation by liniments, or otherwise, may then be necessary, or a supporting brace may become advisable.

If, however, the sprain does not come to hand until swelling, effusion, or inflammation has set in, success with the bath will not be so marked, and hot, cold, or evaporating lotions, the ice-bag, and perhaps poultices and counter-irritation will take the place of tight bandaging until swelling goes down sufficiently to justify the plaster dressing.

WOUNDS OF JOINTS.

Wounds of joints are of two classes; those opening the joint through the integument, including such accidental wounds as lacerated, incised, punctured or gunshot, and the premeditated ones of the surgeon; and those attacking the articulation from beneath the integument, such as frac-

tures and dislocations. The latter class may communicate with the air and likewise become, as are all those from without, open (compound) wounds. All open wounds of joints may be, or become, septic or poisoned from outside influences; but closed joint wounds can only become infected or septic from the blood, by sloughing of their coverings, lymphatic conduction, or from rupture of the deep glands of the skin.

Diagnosis.—Closed wounds of joints have been discussed under other headings, and need not further concern us here. Open wounds in the neighborhood of joints now have comparatively few points of diagnosis or differential diagnosis capable of puzzling the surgeon, because the very mode of treatment establishes the exact nature of the wound. That is, all wounds must be thoroughly cleansed. Hence wounds near joints are to be opened up to their bottom, if at all deep, and incidentally their nature is thus established. The danger of mistaking serious for trivial injuries until sepsis sets in is thus avoided. Joint wounds may be palpable from their extent, display of cartilage, flow of synovial fluid, or be made so by exploration.

If the case is old, a wound which has entered a bursa and set up suppuration must not be mistaken for articular involvement. To avoid such mistakes, even in cases where there seems to exist no doubt that the joint is involved, it should not be laid open before penetration of its cavity is proved.

Early reached and properly treated, uncomplicated open joint wounds should almost always progress favorably to perfect cure, with unimpaired utility. But if infection has taken place and suppuration set in, the case is one of utmost gravity. (See Acute Purulent Arthritis.)

Treatment.—Any wound or open fracture near a joint should be regarded with extreme care and suspicion. The surrounding parts should be cleansed and the wound then investigated. If the wound stop before entering the joint it should be cleansed, sutured, and the limb be put upon a splint until fairly healed. But if a probe or the finger carried in enters the joint, or, this failing, the wound has been laid open and proved to penetrate, the opening into the synovial cavity should be made sufficiently large to wash out the joint thoroughly with 1 : 1000 corrosive sublimate solution.

The articulation having been freed from foreign matter and the synovial membrane and integument separately sutured with chromic catgut, a dressing and splint are applied and left for three weeks, when passive movements are to be commenced. Subsequent local or constitutional signs of inflammation in the joint will indicate immediate re-opening, irrigation, and possibly curetting of the cavity, and the introduction of a rubber drain-tube to the bottom of the joint.

Violent septic arthritis must be met with free incisions, curetting, washing, and gauze packing of the entire joint. Or, if these measures fail, and without resorting to them in aged or broken-down individuals, excision or amputation must immediately be performed.

Open or compound dislocations are to be cleansed, reduced, the joint irrigated, usually a drain-tube introduced, the synovial membrane, torn ligaments, etc., sutured as far as possible into normal position and the outer wound united.

If reduction cannot be effected, even after free incisions have been made, the end of the dislocated bone must be excised.

Sometimes a splinter of an open fracture will wound a joint situated a long distance from the original injury. Especially is this apt to occur in

longitudinal fractures of the upper tibia. Proper treatment of the open fracture would, however, eliminate danger from the joint opening, but a septic condition of the fracture will almost invariably be followed by dire consequences to the knee, and perhaps kill the patient. Open and communicating fractures involving a joint demand prompt exploration of the same, removal of fragments, blood, etc., or excision, or amputation, according to circumstances. Precisely the same is to be said for gunshot wounds involving joints; if the joint surfaces are only grooved or cracked, however, washing out and drainage will alone be required.

In all cases of joint injury rest and immobilization for weeks must be insisted upon.

If effusion, swelling, and disability persist after healing of a joint wound, active counter-irritation, a rubber bandage, massage, or some form of supporting apparatus must be employed.

(See Chronic Arthritis, Chronic Synovitis, Ankylosis.)

Dislocations.

Definition.—A dislocation or luxation is a violent displacement of a bone from its normal relation with another bone at the place of mutual articulation. The term dislocation is similarly applied to an intra-articular fibro-cartilage when it has been displaced from its normal position. It will be seen that I limit the term to articular displacements due to traumatic or muscular violence, as I regard the so-called pathological or spontaneous dislocations as mere symptoms of other diseases, generally arthritis or paralysis of muscles, and the congenital dislocations instances of malformation from arrest of development or fœtal disease. I admit the possibility of congenital dislocations being sometimes due to violence received by the fœtus *in utero*, but such a bare supposition does not warrant the application of the term dislocation to conditions which resemble other congenital arrests of development. The term "old" is applied to dislocations which have not been reduced for some time after their occurrence. The definition, it will be observed, is quite arbitrary and ambiguous, and no rules can be laid down to demark the exact time when an acute dislocation becomes one of this class. Thus a dislocated elbow is commonly spoken of as "old" when it has remained unreduced for three weeks, and a similar persisting lesion at the shoulder-joint assumes the term when it has existed from four to seven months.

That bone which is more remote from the trunk is the one which is said to be dislocated. Thus dislocation at the hip is called a dislocation of the femur, not of the innominate; dislocation at the knee is termed a dislocation of the tibia, not of the femur; and dislocation of the ankle is denominated a dislocation of the tarsus. The displacement of the bone may be in various directions; thus, backward, forward, upward, downward, or laterally. Each joint is liable to sustain dislocation in certain directions rather than in others, this tendency being due to the shape of the articulating surfaces and the manner of muscular and ligamentous attachments about the joints.

Dislocations at amphi-arthrodial joints, such as are found between contiguous vertebral bodies, at the pubic symphysis, and between the segments of the sternum, are sometimes called diastases. I prefer to restrict the term diastases to epiphyseal fractures, and to apply the words dislocation and luxation to these as to other joints.

A dislocation is complete when no portion of the articular surfaces remain in contact. Complete dislocations are rare in hinge-joints, but common in ball-and-socket articulations. Incomplete or partial dislocations, often called subluxations, are luxations where the displacement is not sufficiently great to cause loss of mutual contact between portions of the articular surfaces. As in fractures so in dislocations, the lesion may be complicated. Laceration of soft parts, rupture of large vessels or of nerve-trunks, fractures involving or not involving the joint-cavity, and similar accompaniments, constitute the complications that make the term complicated dislocation applicable. When an external wound leads to the seat of dislocation the injury is called an open dislocation, in contradistinction to one not so exposed to the entrance of air, which is a closed dislocation. The terms "compound" and "simple" are as undesirable here as in connection with fractures, and I have accordingly employed the better terms, "open" and "closed."

When a dislocated bone has its primary position altered by efforts at reduction, involuntary muscular action, or other cause, a consecutive or secondary dislocation is said to exist. For example, an iliac dislocation of the head of the femur may be converted into a sciatic dislocation; the latter would then be called a consecutive or secondary dislocation, the former a primitive or primary one.

Causes.—The predisposing causes of dislocation are relaxed or stretched ligaments, muscles weakened by paralysis or atrophy, old tears in the ligamentous capsule, and imperfections in the socket from either accident or disease, and such relation of the normal articular surfaces and ligaments as will readily permit displacement. The greater the normal freedom of motion, and the more exposed the joint is to accidental blows, the greater is the tendency to suffer dislocation. Hence the preëminent frequency of luxations of the head of the humerus. Dislocations at the elbow occupy in point of frequency the position next to dislocations at the shoulder, which are the commonest of all luxations. Certain positions of the bones at the moment of receipt of injury tend to allow the occurrence of dislocation. Thus a blow on the chin is more apt to dislocate the jaw if the mouth is open at the time; so axillary luxation of the head of the humerus is more readily produced when the arm is abducted and elevated.

The exciting causes of dislocations are external violence and muscular contraction. The strength of the ligaments surrounding the joint and their disposition in relation to the direction of the applied force will often determine the direction of the dislocation and also the character of the injury; that is, whether it shall be a fracture or a dislocation, or both; for violence will usually either break or luxate, according as the force drives the bone toward the weak or strong portions of its ligamentous capsule. External violence may exert itself directly upon or near to a bone or joint, or indirectly as when applied at a distant point or extremity of a bone or limb, the intervening bone or bones and their attachments acting upon the principle of one or other of the classes of levers to produce the luxation. Thus a fall upon one foot whilst the body is in an erect posture may produce a dislocation of the knee or hip, and a case is recorded where a blow of the fist upon the upper portion of the humerus produced a dislocation of the head of that bone from its articular cavity. Likewise, twisting forces are common causes of certain dislocations, notably those of the ankle, hip, and elbow. They are apt to occur in this manner when one portion of an extremity is held firmly whilst the other is given a rotary, lever-like motion, as when the foot is suddenly

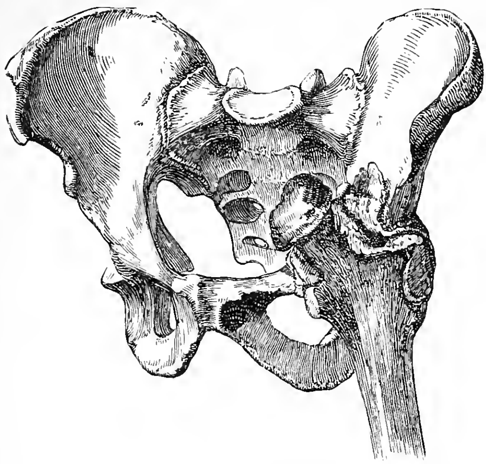
caught and the whole weight of the body is thus brought to bear on the ankle-joint, dislocation will be the almost inevitable result. It is most probable that muscles frequently lend great assistance to external violence in the production of dislocations, for it is a well-known fact that men whilst intoxicated seldom sustain dislocations, and that much more force is required to produce luxations in the cadaver than in the living body. Muscular action may give rise to dislocations suddenly, as during voluntary motions or convulsive seizures of any description, or in a more gradual manner, as is witnessed in certain pathological changes in joints, or as a result, perhaps, combined with the former, of chronic contractions or contractures, producing the so-called "spontaneous" dislocations. These causative factors are all accidental or pathological, but there are certain persons who, through possession of loose articulations or injury, have developed habitual dislocations, and can at will produce and likewise replace these deformities. Muscular contraction is a very important element in the study of dislocations, for it may increase displacement, render the course of the displaced bone to its present final position uncertain, and in some cases greatly increase the difficulty of reduction. Distention of joints by fluid renders their bony elements peculiarly liable to displacement by either muscular or traumatic action. Fracture or unequal growth of one of two parallel bones renders joints situated at their extremities prone to luxation, or even may directly cause that accident.

PATHOLOGY.—The pathology of dislocations is of great interest. In incomplete dislocations little change is to be noted; the ligaments are stretched but not usually torn and ecchymoses may be present in and about the joint, but seldom does any momentous damage or impairment of function result. Complete dislocations, on the other hand, nearly always present tearing of ligaments, surrounding tendons, and muscular attachments, particularly those having origin from or insertion into the capsule itself. If the dislocation be typical there is apt to be quite limited tearing of ligaments, but where extensive laceration has taken place the resulting deformity will usually be irregular. The capsule of a dislocated joint need not of necessity be ruptured, but may be entirely stripped from its bony attachments. In complete luxations of hinge-joints the ligaments are frequently merely stretched, but such displacements of ball-and-socket articulations are always attended with laceration of the capsule. This rent most frequently consists of a linear slit through which the head of the bone has been shot. It is situated, as a rule, near the rim of the glenoid cavity in the shoulder and in the hip at the acetabular edge. A knowledge of the probable location of this rent is of utmost importance in reduction.

The luxated bones are apt to render more or less damage to surrounding structures, and muscles, nerves, arteries, fascia and skin, either or all, may sustain injury thereby. They may be stretched, bruised, or torn, the latter, in cases of arteries such as the popliteal at the knee or the axillary at the shoulder, being most formidable complications. Modern surgery has rendered open dislocations, as those involving communicating lesion of the skin or mucous membrane, of practically the same pathological significance as the closed variety. In voluntary muscular, also in certain pathological dislocations, the ligaments are simply stretched and surrounding structures are not of necessity injured. If the joint is quickly restored to its normal relations by reduction and maintained at rest for the requisite time, the injured ligaments and other structures quickly regain their normal condition, although the joint may always be weak and more liable to future displacement than before it

received the primary injury. If, on the contrary, the dislocated bone remains in its new and unnatural situation a remarkable series of phenomena take place. The margins of the now unused socket atrophy and

Fig. 282.

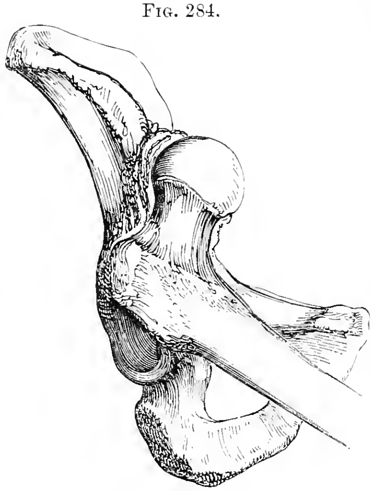


Old unreduced suprapubic dislocation of the hip. (Cooper.)

disappear, it becomes more shallow, and finally is obliterated by bone and fibrous material. This process will occupy in different cases times varying from a few months to many years, and cases are upon record where no

Fig. 283.

Fig. 284.



False joint resulting from unreduced dislocation of femur. (Cooper.)

especial changes had occurred after a lapse of ten years and it is to be presumed that in these cases no change would ever have taken place. Where the socket thus remains the synovial membranes and cartilages

have been preserved and have resisted atrophic influences. The dislodged head of the bone meanwhile has created a new socket or cup-shaped depression for itself by pressure, atrophy and condensation of the structures upon which it rests. The new socket will, in time, have raised edges, be lined with eburnated bone-like or fibrous material, which sometimes becomes covered with a membrane resembling true joint or synovial membrane, which secretes a lubricating fluid having many of the physical attributes of true synovial secretion. A species of capsule may even envelop the new joint in course of time. The head of the bone usually undergoes some flattening and atrophy, but may remain unchanged. The formation of a new joint is rapid in children but occupies years for its completion in any save the most youthful adults. By these natural resources very fair function of a limb may be regained, even if the luxation continue unreduced and unsightly deformity remains. The pathological significance of inflammation about dislocations is very great, for by its means vessels and nerves are apt to form adhesions to the displaced bone extremity, which may give rise to rupture of those structures when attempts are made at reduction. Inflammation and its effects may also permanently ankylose a joint which has been dislocated, or may even, in predisposed individuals, give rise to purulent arthritis.

Symptoms.—The principal symptoms of dislocation are:

1. Deformity.
   (*a*) Absence of a known prominence.
   (*b*) Unnatural presence or disappearance of a depression.
   (*c*) Changes in length, axis, and general conformation.
   (*d*) Swelling.
2. Rigidity.
3. Absence of crepitus.
4. Pain.
5. Force not generally required to maintain in position after reduction.

The diagnosis and differential diagnosis of luxations cannot be made out with a single sign; sometimes it is impossible, even to the most experienced, when all available diagnostic resources are brought into requisition. In this section it is proposed to describe principally typical dislocations, and not to enter upon their differential diagnosis, as that has already been elaborated under Fractures.

Deformity, more or less marked, is an inevitable accompaniment and sign of dislocation. The bones entering the structure of a joint are displaced, and hence it is impossible that its contour and appearances should not be changed. The position of these separated joint elements is usually the same and typical for the same dislocation. The absence of one element of an articulation is noted, and an unnatural prominence has made its appearance in the vicinity of the joint, the axes of the bones are changed from that of their normal relation to each other, and there have occurred various other changes, as in the length and circumference of the limb. Certain attitudes, which will be described under Special Dislocations, are significant of particular dislocations.

The swelling which is apt rapidly to supervene when displacement has occurred is not usually so great as to prohibit diagnosis, although not infrequently this symptom may entirely mask the true nature of the injury. Strong pressure with the fingers or hand, or an elastic bandage for a few moments, may so dissipate infiltration that salient prominences and landmarks, or even all portions of the affected bones, may be made out. This failing, the judicious use of a well-tempered exploring needle may determine

relative positions. When swelling has come on with great rapidity, and circulation has ceased in the distal distribution, rupture of the main artery most probably has complicated the original injury. Preternatural rigidity or loss of function also usually accompanies dislocation. Separated joint surfaces, as a rule, have the same relation to each other in the same dislocation, and are held firmly and rigidly in that position unless great laceration of ligaments or profound shock also be present, when the contrary, or even extreme mobility, may substitute this symptom. Immobility is rarely absolute, and some degree of motion can usually be elicited, which is limited by a more or less *elastic check* imparted by the remaining portions of ligaments and the resistance of soft parts surrounding the dislocated bone. If the injury is also associated with fracture, rigidity will not usually be present. Utmost caution must be used in diagnosing dislocations, in patients whose age permits the possibility of epiphyseal fractures, to distinguish the former from the latter, as both possess points of great resemblance.

The corresponding bones, joints, and regions of both the injured and sound side of the body should always be compared, and the two hands made to examine synchronously and contrast the corresponding depressions, prominences, and "landmarks" of the two sides. If this be made a rule of practice and procedure, many an incorrect diagnosis arising from inappreciation of the peculiar topography of the patient under consideration will be avoided, and still other cases will thus be quickly robbed of their diagnostic difficulties.

True crepitus cannot be developed in a case of dislocation unaccompanied by fracture, but it is likewise true that this sign cannot be developed in every case of fracture. Often a friction sound or sense can be perceived in dislocations, which is developed when compressed fibrous or muscular tissues and the displaced bone are moved upon each other, and the simple movement of dry or otherwise altered synovial membranes is quite sufficient to produce this "false crepitus." This symptom is unusual in very recent luxations, and does not often make its appearance until one or more days have elapsed since the occurrence of injury; but friction of a torn ligament may give rise to it at any period of the case. Dislocation crepitus is much more obscure than is that of fracture, unless the latter happen to be deeply situated or when inflammation has caused softening of the disrupted surfaces. A dislocation complicated by a small fracture, as of a chip from an acetabular rim or a torn-off tuberosity, may present either or both forms of crepitus. Such injuries are often impossible of more exact diagnosis than supposition.

Pain in dislocations is frequently more unbearable, and of a dull throbbing or stretching and tearing variety than is the case with that of fractures. If nerves have been pressed upon or torn, tingling, numbness, or anæsthesia and paralysis of their distributions will be temporarily or permanently present, according to the degree of nerve injury sustained. Muscles are placed upon the stretch, and the bone extremity is probably pressing powerfully upon surrounding structures—an aggregate of causes quite sufficient to account for the very marked subjective symptoms of which cases of dislocation so often pathetically complain.

Unless taken in conjunction with all the other signs of dislocation retained position after reduction is a symptom of no great moment. It is a fact that dislocations when reduced customarily remain in position, but the contrary is as often true if there has been great laceration of liga-

ments or soft parts, whilst many fractures, notably certain ones about the wrist, will retain their position perfectly when set or reduced.

Open or compound dislocations present very little difficulty in diagnosis, for their character is easily cleared up by the opportunity for direct examination which is afforded during the necessary process of treatment.

Luxations complicated by fracture have been discussed under the latter heading. They are injuries of much gravity as regards diagnosis, treatment, and prognosis.

Prognosis.—The general prognosis of a given dislocation is favorable or unfavorable in direct ratio to its complications. Simple luxations promptly and completely reduced and kept at rest for the requisite length of time practically never of themselves endanger life, limb, or function; the slit in the capsule firmly heals, the displaced surrounding tissues quickly return to their former condition, and little save some swelling and perhaps some pain and stiffness remains to remind the patient of his recent accident. But this pain and stiffness—usually the result of the necessary immobilization of the joint to insure healing of the torn structures—may continue for a long time or even in exceptional instances lead to permanent disability. Some weakness or atrophy may also follow simple displacements; this probably being due not only to inaction of the muscles but also in part to stretching or bruising of the proximate nerves or muscles. Atmospheric changes are apt to have a forecast in the painful stiffness which the injured parts may assume before a change of weather, for perhaps even years after dislocation. Much also, in all forms of dislocations, depends upon the particular joint involved, the degree of the displacement, the condition of health and the reparative powers of the individual, the means employed for reduction, and the time after accident when treatment was instituted.

Thorough reduction may be rendered impossible by a portion of ligament or muscle occupying the joint cavity, and preventing the replacement or retention of the dislocated bone.

Secondary or recurrent dislocations are rarely of special danger, but the prospects of permanent cure are extremely slight. When luxations are complicated by rupture of the main artery of an extremity the prognosis becomes most grave, and loss of the limb or even of life is the common result. Torn nerves, muscles, or tendons are not of such serious import, as they can often be restored to functional activity by operation.

Open dislocations have been robbed of most of their former terrors and dangers by modern wound treatment, but they will always be much more serious injuries than simple luxations, from their liability to become infected. If they can be guarded from this latter complication the chances of saving the joint and ultimately restoring it to usefulness are very good.

Old dislocations or recent ones, which it is found impossible to reduce, are not to be prognosticated so unfavorably as might at first sight seem necessary, for often by the formation of false sockets and articulations much of the functional activity of a limb may be restored, which usefulness is prone to increase, not to decrease as time goes on. But, unfortunately, pressure exerted by the bone in its new location may cause much distress or danger. The degree of disability in these ancient dislocations will depend largely upon the nature of the joint involved. Thus ball-and-socket joints when unreduced give rise to much less interference with function than do similar conditions in hinge joints, and even one variety of dislocation may give rise to less disability than another at the same articulation. Thus, deformity is much less in a sciatic dislocation at the hip or a subglenoid at the shoulder than is the deformity resulting

from other dislocations of the corresponding bones. Attempts to reduce old dislocations are always serious undertakings, from the danger of rupturing arteries which may, through inflammatory action, have become attached to the displaced bone or its fibrous surroundings. Especially is this danger salient in old luxations of the humerus.

Treatment.—Spontaneous reduction occasionally takes place, more especially in partial luxations and in those of the shoulder. This desideratum may be brought about by movement during sleep, falls, or after unsuccessful attempts at reduction have failed of their purpose, but have so broken up adhesions that the force of muscular contraction or voluntary motion afterward draws the displaced bone into position.

Except in certain complicated cases, treatment of acute dislocations should always be instituted at the earliest possible opportunity, and the earlier reduction is attempted just so much more readily can it be attained.

There is often a period lasting a short time after the accident during which the muscles have not begun to contract, and at this time some dislocations are most readily reduced. The writer once had opportunity to prove this assertion in the case of a fellow swimmer who sustained a subcoracoid dislocation of the humerus by his arm being forced upward and outward in striking the water whilst diving. It was reduced with utmost ease by manipulation before more than one or at most two minutes had elapsed. No especial care was taken of this member afterward, but dislocation never recurred. The indications for treatment are: 1, to reduce the dislocations; 2, to secure firm repair without inflammation, and 3, to restore function.

Reduction is to be accomplished by constitutional relaxing measures, and by manipulation. Mechanical force is never required or permissible in recent luxations. Prolonged painful efforts to reduce a dislocation should never be made, and relaxation by ether should be secured in all rigid dislocations of the larger joints; also in case of *any* joint should it resist our first few efforts or give rise to excessive pain upon motion.

The primary stage of ether, or some abrupt question or accusation put to the patient, may occasionally direct attention from the injured parts and permit the surrounding muscle to be surprised and the joint reduced by a rapid manipulation, but, usually, anæsthesia to the stage of profound relaxation must be attained before manipulation can properly be applied and reduction effected.

Fig. 285.

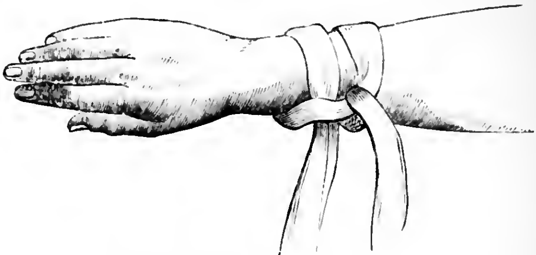
Clove-hitch knot.

Reduction made without the addition of mechanical force to the ordinary powers of the surgeon constitutes replacement by manipulation, which method is always preferable to any other. But in certain cases the hands of an assistant may be additionally employed or a better hold upon the part obtained by wrapping it in cloths, or by throwing a "clove-hitch" or noose knot above some bony prominence, which will prevent slipping or damage by traction upon soft parts.

The object of manipulation is to secure through one or more consecutive processes of extension and counter-extension, rotation, pressure, adduction, abduction, flexion or extension, the replacement of the dislocated bone. By these processes relaxation of some structures and tension of others is

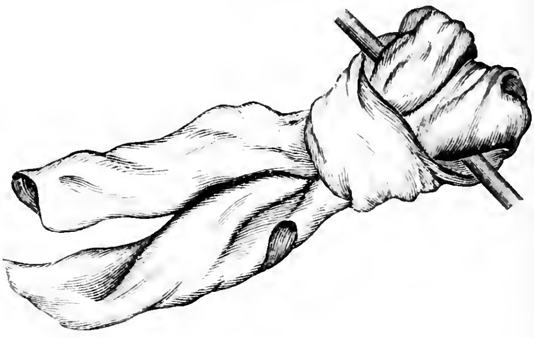
attained which either assist, permit others to assist, or are prevented from hindering the return of the bone to its socket by the route of exit. From this it will be seen that to reduce luxations by manipulation an accurate comprehension of the mechanism of dislocations must be possessed by the surgeon who may be called upon to replace them. *Rude* manipulation if

FIG 286.



Clove-hitch knot applied. (AGNEW.)

FIG. 287.



Noose knot.

persisted in may often accomplish reduction in the hands of ignorant persons, but exact anatomical knowledge is vastly safer, more satisfactory, and successful. The surgeon should be familiar with those motions best calculated to relax the bone capsule, or to remove other obstructions, and to bring into play such muscles or ligaments as will assist him in his endeavors to replace the bone. Sometimes a rocking motion combined with manipulation will insinuate an obstinate bone into its proper position. Manipulation to prove successful must be applied systematically, and the sequence of its various objects must follow in regular order. Thus, obstructive tension is first to be overcome. Then the bone is to be dislodged and gotten opposite the capsule rent and finally forced into position; which last two procedures are often accomplished through making portions of ligaments, etc., act as pulleys or levers. As the capsule rent is made by pressure of the head of a bone, hence the lesion is always in the direction of dislocation, and the rule is always, if possible, to return the bone in the exact direction of dislocation. If only a slit exists in the capsule that ligament must be relaxed to permit reduction, but unless a flap has been torn from one edge the capsule will never prevent reduction

by occupying the normal position of the displaced bone. The existence of an obstructive flap is an extremely unfortunate occurrence, and one which nothing short of an operation will relieve in some cases. Reduction will sometimes be further obstructed by muscles or tendons slipping over or under the dislocated head. For these complications, as when the metacarpal bone of the thumb slips under a head of the flexor tendon, nothing short of division of the restricting band will suffice, that the reduction may be completed.

If swelling interferes with reduction we should be content to wait until it in part or wholly subsides. This takes place with rapidity, and little is lost by the pursuance of such a course.

But cases will occasionally be encountered in which manipulation will fail, or where anæsthesia is refused or inadmissible, and to these we will be driven to apply the application of force. This agent is brought into action by means of extension and counter-extension, energetic rotation, and by direct or indirect pressure, or one or all of these measures in connection with manipulation. The required force must gain access to the limb through certain mechanical attachments. If bandages or cloths are used for this purpose they should previously be moistened, for in that condition they are less liable to slip.

Clove hitches, noose knots, elastic bands, or the metal attachment plates of Levis, which are shown under Refracture of Deformed Union After Fracture, can be used for this purpose. Great caution must be observed that pressure or traction be not made upon the skin or soft parts, but that bone extremities are made the points of resistance. By these means indefinite extension and power, limited only by the strength of the distal bone, may be secured. Forcible reduction should be made to simulate the motions of manipulation as nearly as possible; but if this cannot be attained then the force should be applied in the direction which will bring the head of the bone directly to the socket, or to such proximity to it that lateral pressure or rotation will complete the reduction.

The power must be applied gradually, steadily, and with the greatest judgment; a rocking motion may be superadded at times with benefit to force the dislocated bone from entanglements, or by chance to slip it into the socket.

Gradual continuous extension by elastic bands or weights acting over a pulley often proves of great utility. Up to fifty, or more, pounds of weight may thus be employed, but it will be found that lesser weights acting for a long time will accomplish more than will greater amounts for a shorter time. Compound and other pulleys, until recently so much in vogue, are to be unequivocally condemned for recent luxations, and only most rarely can there ever arise necessity or indications for them in any form of dislocation. Anæsthesia is as beneficial and requisite during the reduction of displacements by forcible means as in manipulation.

Force is to be applied as follows: 1. The power is to be exerted in a proper direction. 2. It must not be applied in a spasmodic or violent manner, but continuously, and with a gradual increase of amount. 3. The part must be rotated and rocked in all directions to free the head of the bone from entanglement or adhesions. 4. When resistance of muscles has been sufficiently overcome to permit the head of the bone to reach the level of the cavity from which it has been replaced, an adroit movement of the part must be made by the hands of the surgeon toward that cavity, whilst at the same instant the extending force should be relaxed by an assistant.

Should even these measures fail, then will arise the advisability of instituting such operative measures as subcutaneous or open division of the restricting tissues, or even of the neck of the dislocated bone itself; the excision of its head or of the whole joint, or, finally, of amputation.

A dislocation is known to have been reduced when the articulation assumes its normal contour and functions, and by the direction of the axis of the limb or the elements of the joint. The fact is frequently announced by the before-mentioned moist or muffled snap. The dangers incident to the application of force are proportionate to the presence and nature of adhesions, and to the amount applied.

After being reduced the joint must be kept at rest by means of splints, bandages, or apparatus for a few days or weeks, according to the severity of the dislocation, the joint involved and the nature of complications.

At the expiration of this time passive motion is begun, and shortly afterward active movements, or customary occupations, may be resumed. But movements in the direction of the former capsule tear should be avoided for as long a time as possible. If these precautions are not considered the risk of recurrence or of establishing an "habitual dislocation" becomes very great. Electricity, massage, hot and cold douches, and injections of strychnia will prove of benefit if muscles have lost their power. Should inflammatory reaction occur its symptoms are to be met with the usual means.

Treatment of Old Dislocations.

Much that has already been said applies equally to the treatment of old dislocations. For reasons already stated it is justifiable to make judicious attempt at reduction of any dislocation, no matter what may be its age. In this variety of dislocation passive motion, poulticing, massage and extension should be kept up for days or weeks before an attempt at reduction should be undertaken. Any restricting tissues should be divided some time previously. Manipulation, even if it does not accomplish its ulterior object, frequently gives the patient a wider range and ability of motion than he had before. Attempts to break up or reduce old dislocations are always to be undertaken with the full knowledge of both surgeon and patient of the great risks to be encountered in all such operations.

The most common accidents attending the modern reduction of old dislocations are rupture of vessels and nerves, fracture, and rendering the injury open or compound by giving way of the skin. Rupture of vessels is almost exclusively limited to arteries, and of the latter, principally to the axillary, and are most fatal accidents under any form of treatment. Their occurrence is recognized by the sudden formation of a pulsating tumor in the neighborhood of the old injury. Exceptionally the artery does not rupture until several days after the attempt at reduction, or an aneurism may form either with rapidity or otherwise. Gangrene of the limb may follow pressure upon or laceration of vessels.

Fracture, if it take place close to the dislocated head may prove of more benefit than injury by forming an artificial joint and save subsequent recourse to operation for the same purpose. Recoveries have taken place in all varieties of these accidents. Torturing neuralgia, persistent œdema, aneurism, varix and gangrene are possible sequelæ of unreduced luxations or of efforts made for their relief.

The treatment of open or compound dislocations has been discussed under Wounds of Joints.

Special Dislocations.

Dislocations of the Vertebræ.

Dislocations of the vertebræ unaccompanied by fracture are injuries of rarity. The ultimate effect of almost all casualties of this nature is lethal; most commonly immediately, but exceptionally death is postponed for months. Some cases recover. The seat of lesion is most commonly in the cervical region, less frequently in the dorsal, and never, so far as surgical history goes, in the lumbar region. The most common dislocation is that of the axis. The cervical region is predisposed to these accidents because of its range of motion and freeness of articulation.

Most dislocations of the cervical spine are simple or uncomplicated, but may be complete or incomplete. The region bounded by the fourth and sixth vertebræ is most vulnerable. Any variety of displacement may injure the cord, rupture its vessels, or give rise to subsequent inflammation or effusion.

The treatment of spinal dislocations consists of reduction, if feasible, and subsequent care of bladder, rectum, and surfaces exposed to pressure, as in fracture complicated by cord injury. The water or air-bed and extreme cleanliness will likewise be found of great utility to prevent pressure necrosis.

Dislocations of the Cervical Vertebræ.

Dislocations below the axis are usually forward; that is, all the vertebræ above the seat of displacement are thrown forward, but lateral or rotary dislocations are not unknown in this region.

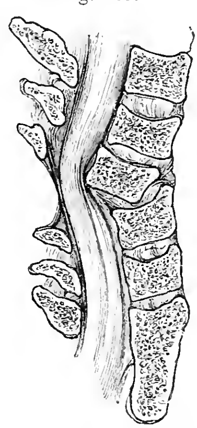
These luxations are caused by indirect violence bending or twisting the neck. If complete, the posterior common vertebral, also the lateral, ligaments are torn.

Save in certain well-marked

Fig. 288.

Bilateral dislocation forward of fifth cervical vertebra. (Ayres.)

Fig. 289.



Dislocation of cervical vertebræ by flexion; median section. (Bryant.)

cases exact diagnosis is very difficult in dislocations of the cervical spine. The head is bent rigidly on the breast in forward, and in the opposite direction in backward dislocations. A prominence or depression, according to the direction of the dislocation, may sometimes be noted by a finger carried into the pharynx. If the injury be above the origin of the phrenic nerves, death is usually instantaneous.

Treatment consists of extension by hands placed upon the chin and occiput and counter-extension by pulling upon the patient's feet; or by means of a folded sheet drawn over the shoulders combined with manipulations calculated to disengage the luxated vertebræ, and direct pressure applied at the same time to the neck and, perhaps, through the pharynx.

Atlo-axoid Dislocations.

Alto-axoid dislocations come next in order of frequency. Three varieties exist: the odontoid process of the axis may be fractured and thus permit dislocation of that vertebra backward and crushing of the cord; the odontoid ligament or some fibres of its transverse portion may be torn and permit the odontoid process of the axis to slip beneath it; or the atlas may be rotated upon the axis until the articular ligaments rupture and permit the former bone to rest obliquely upon the latter. These lesions result from force applied to the head, from falls, blows, and twists; whilst the presence of vertebral caries greatly predisposes to them. The symptoms and consequently the exact diagnosis of these, as of other cervical dislocations, are vague and unsatisfactory. They usually prove rapidly fatal, and great precaution must be observed in the treatment, as instant death is liable to follow even trivial attempts at reduction, from injury to the cord by pressure from the odontoid process. Nevertheless, it is our duty to attempt such reduction by traction (as above) in the line of the spinal column, manipulation, and direct pressure. If success attends the surgeon's efforts care must be taken to retain the head in the proper position by pillows or other means.

Occipito-atloid Dislocations.

Occipito-altoid dislocations are occurrences of great rarity and fatality, being due to great violence tearing the condyles of the occipital bone from the articulating cavities of the atlas.

Dislocations of the Dorsal Vertebræ.

Dislocations of the dorsal vertebræ occur, but usually are accompanied by fracture, because of the great force required to lacerate the powerful ligaments and joints which are to be found in that region. They are caused by violent flexions or rotations of the body. The diagnosis is self-evident and precisely similar to that of fracture in the same region, and treatment consists of application of the same measures as for other vertebral displacements, except that continuous extension and counter-extension should form a more prominent feature of after-treatment.

Dislocations of the lumbar region without fracture are unknown. They require no separate consideration.

Dislocations of the Ribs from the Vertebral Column.

A few cases of this variety of injury appear in surgical history of times now remote; none have been recorded during the past forty-four years. They, as a rule, accompany terrific lethal traumata. Diagnosis is made by the absence of the head of the rib from its vertebral socket, and treatment is to be supplied by a broad band highly encircling the chest.

Dislocations of the Coccyx.

These unusual injuries take place principally in women, resulting from falls, kicks, or other direct violence, or during parturient efforts.

Three varieties have been observed: forward, which is most frequent, backward, and lateral. The symptoms of the accident are great pain, swelling over the region, and rectal examination discloses the displacement and its variety.

The forward luxation is to be reduced by hooking the finger over it in the rectum and drawing it downward into position. Beyond manipulation and pressure, no definite rules can be given for treating this form of luxation. Instant relief follows replacement, but recurrence is probable. Old or inveterate dislocations may demand excision of the affected parts. (See Excision of Joints.)

Dislocations of the Jaw.

This dislocation occurs in four per cent. of all luxations. It may be partial, bilateral, or unilateral. A shallow gelnoid fossa and lax articular ligaments predispose to the injury; whilst yawning, laughing, sneezing, blows, and falls are exciting causes. Attempts to separate the jaws excessively, or blows upon the chin whilst the mouth is open, are prolific causes of luxation.

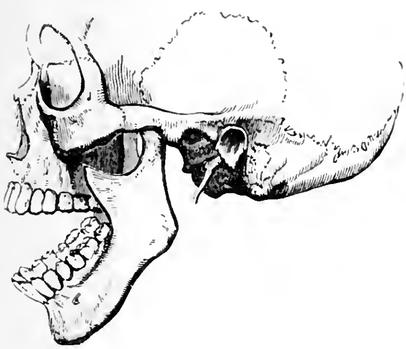
The mechanism of this dislocation is brought about by the internal pterygoid muscles becoming a fulcrum, and the muscles inserted into the chin becoming, as it were, the long arm of a lever, which, with the assistance of the external pterygoids, cause the condyles of the jaw to press upon and rupture the capsular ligaments, and spring in front of the articular eminences, when contraction of the masseter and temporal muscles draws them forcibly upward until they are arrested by the zygomatic arches and the typical deformity is produced. Rarely the capsule is not torn.

The symptoms are wide separation and firm fixation of the lower jaw; a vacuity is noticed in front of the ear, and the condyles may be felt beneath the zygoma.

A backward dislocation has been described in which the condyles are violently forced through the anterior wall of the auditory canal. Anæsthesia is not required in the treatment of this dislocation, which consists in the surgeon carefully protecting his thumbs with strips of bandages, and then with them pressing downward upon the last molar tooth upon each side of the jaw, whilst, at the same time, the palms and fingers grasp each side of the maxilla externally and press it backward. By these manœuvres the process of dislocation is exactly reversed; tension of the internal pterygoid and masseters is overcome by the downward pressure; the condyles are pressed backward into position, and, upon releasing the

pressure, are drawn with great force into position by contraction of the temporal and masseter muscles. If the surgeon's fingers are not protected or removed to the side of the teeth quickly, they are liable to be injured from the force with which the molars are drawn together.

FIG. 290.



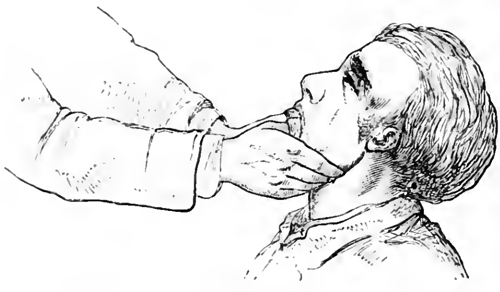
Bilateral dislocation of lower jaw.

FIG. 291.

Deformity resulting from bilateral dislocation of lower jaw. (ASHHURST.)

Unilateral displacements are to be treated in a similar manner. If in subluxations the teeth are firmly together, simple forcing of them apart will suffice for reduction.

FIG. 292.



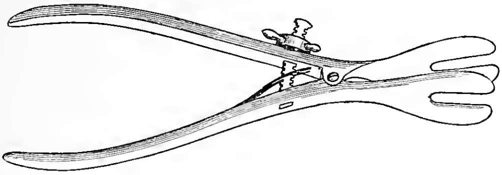
Reduction of dislocated jaw. (ERICHSEN.)

Old maxillary dislocations are to be treated as acute ones first, and, this failing, the forcing apart of the posterior portions of the jaw by levers or Stromeyer's forceps, or even the excision of the condyles, is permissible.

After reduction the jaw must be kept immobilized for at least a week by means of a Barton or similar bandage, and the patient fed principally upon liquids. If this rule is neglected there is great danger

of recurrence or of the establishment of habitual exarticulation, subluxation, or a snapping sound during eating.

FIG. 293.



Stromeyer's forceps.

Dislocations of the Sternum.

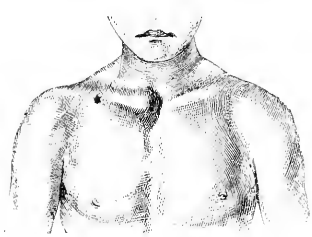
This dislocation is unusual and, from the violent nature of the force required to produce it, has proved fatal in almost 50 per cent. of cases in which it has occurred. Direct force is the usual cause. Reduction is impossible in most cases, but, if the patient survive the complications he is not, as a rule, incommoded by the resulting deformity. Extension of the chest by bending the dorsal spine over a block of wood or round pillow together with manipulation and moulding may be tried, and should they prove successful a broad bandage must highly encircle the chest for some weeks subsequently. Anæsthesia will favor replacement.

Dislocations of the Clavicle.

I shall speak of luxations of the outer end of the clavicle as dislocations of the scapula.

Dislocations of the clavicle occur at the sterno clavicular articulation in either a forward, backward, or upward direction. Dislocation at this joint is favored by a shallow glenoid cavity and by the great range of shoulder motions, which indirectly affect the clavicular articulation. The disarticulation may be complete or incomplete.

FIG. 294.



Dislocation of sternal end of clavicle. (BRYANT.)

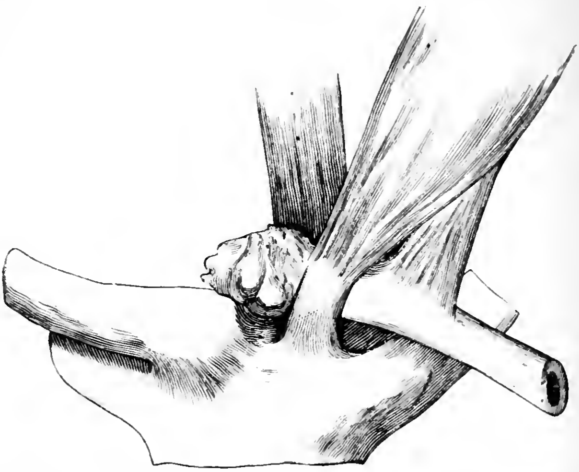
Hypertrophied or violent movements of the shoulder are the most universal cause, but slow dislocation may result from nature of occupation stretching the retaining ligaments. All dislocations in this region are very easy of reduction by proper manipulation of the shoulder and direct pressure combined, but are more than correspondingly difficult to retain in place.

The symptoms are sharp local pain and head of clavicle in new position, before, above, or behind normal situation. In backward displacements aphonia and dysphagia of varying degrees may be caused by pressure of the dislocated head upon the trachea and œsophagus. These latter symptoms rapidly disappear even if the luxation continues unreduced.

Treatment is usually successful so far as primary reduction is concerned, but recurrence is almost inevitable, and sooner or later becomes habitual

or permanent. The head of the bone may be excised if it produces dangerous or painful pressure symptoms. In reduction the shoulder must be drawn outward and forward in forward dislocations; outward and backward in backward, and upward, or upward and outward, in upward dislocations. By these shoulder manipulations in all three varieties the dislocated head is coaxed to the margin of its socket, when direct

FIG. 295.



Dislocation upward of the sternal end of the clavicle. (R. W. SMITH.)

pressure and moulding are applied, and the process is restored to its normal position. When reduced it must if possible be supported for four weeks by means of bandages (such as the Velpeau) and pads, or by a spring truss or other form of mechanism. Pressure must be exerted in the direction of the articulating cavity.

Fractured clavicle position in bed, in addition to the above means, yields the best results. Backward displacements always prove the most tractable.

Dislocations of the Scapula.

These displacements are usually called dislocations of the acromial end of the clavicle, but in accordance with the rule that the distal bone is the one dislocated, they are here termed dislocations of the scapula. As in the case with most luxations they may be complete or incomplete. When complete the dislocations of the scapula may be sub-, supra-, or post-clavicular. Their general causes are direct violence to the shoulder or muscular effort. When scapular dislocations are complete not only are the ligaments of the scapulo-clavicular joint ruptured, but also often portions or the whole extent of the conoid and trapezoid are torn.

Subclavicular dislocations are recognized by the elevated acromial end of the clavicle and the partial rotation of the inferior angle of the scapula toward the spine, which latter symptom is due to the dragging weight of the arm. There is marked local pain, and the attitude attributed to fracture of the outer end of the clavicle is, in these cases, likewise assumed.

Treatment consists of upward, or upward and outward, or backward

movements of the shoulder, together with direct pressure and moulding. In doing this the arm should be kept in contact with the patient's chest. whilst upward pressure is made upon the elbow.

Fig. 296.

Subclavicular dislocation of scapula. (Bryant.)

Retention of the injured parts is difficult. A Velpeau or similar bandage or apparatus, or a broad strip of adhesive plaster carried beneath the elbow, up both sides of the arm, made to cross over the acromial end of the clavicle and secured upon the chest, back and front, must be worn, preferably in conjunction with the dorsal position in bed, for a month.

Supraclavicular dislocations present the acromion raised whilst the clavicle can be traced to a certain point beneath, when it disappears to palpation. Reduction of this variety is to be accomplished by downward and backward traction upon the shoulder, whilst the arm is kept parallel to the trunk, and counter-extension is exerted by traction upon a sheet wound around the chest.

Post-clavicular dislocation has only twice been observed in surgical history. It is to be recognized by the position of the clavicle directly in front of the acromial process of the scapula. A mingling of various shoulder motions and manipulation would probably reduce the displacement. After-treatment would be the same as for the previous varieties.

Dislocations of the Humerus.

These are the most common of all the dislocations, a fact readily explained by the shallowness of the glenoid cavity, the lax capsular ligament, and by the great range of motion and liability of the shoulder to direct or transmitted traumata. Middle life is the most common time of occurrence, and the accident is rare at its extremes.

Dislocations of the humerus group themselves into three principal varieties, which, in order of frequency, are: 1. Downward and somewhat inward, or subglenoid, often termed axillary. 2. Forward, which embraces two sub-varieties, the subcoracoid and subclavicular. 3. Backward or subspinous. Other technical or irregular dislocations also have taken place, but possess no clinical importance.

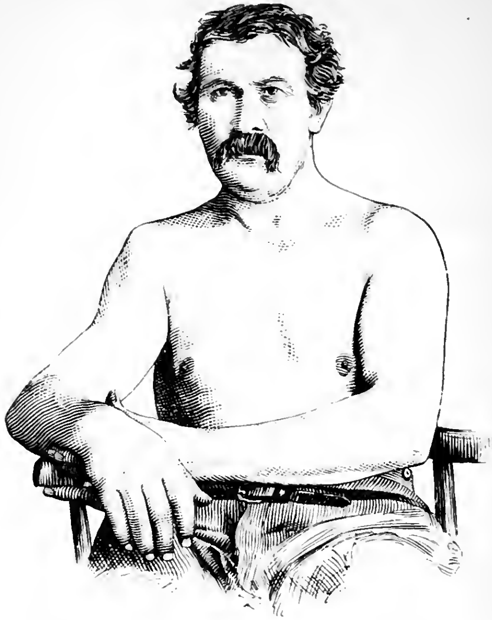
Direct or, most commonly, indirect violence is the exciting cause of dislocation at this joint. Thus, waggons passing over the shoulder and fist blows upon the arm have produced it, but in vastly more instances the head is exarticulated by force employing the arm as a lever.

Downward or Subglenoid Dislocations.

In downward dislocation of the humerus the capsular ligament is torn extensively upon its lower surface, the head of the bone occupies a position upon the anterior surface of the scapula immediately beneath or, perhaps, beneath and a little to the inner side of the glenoid cavity, where it is held between the tendons of the triceps and subscapularis muscles.

The axillary contents are compressed and the circumflex nerve may be so stretched or torn as to result in permanent paralysis of the deltoid.

Fig. 297.



Deformity of downward or subglenoid dislocation of the humerus. (Stimson.)

Whilst the bone is thus situated the deltoid and spinati muscles are made exceedingly tense, or may even be partially ruptured; the subscapularis

Fig. 298.

Downward dislocation of humerus. (Gross.)

and craco-brachialis muscles are likewise upon the stretch, but to a less marked degree, and the teres major and minor are relaxed. The

long head of the biceps muscle may have been dragged out of its groove, or the great tuberosity of the humerus torn off.

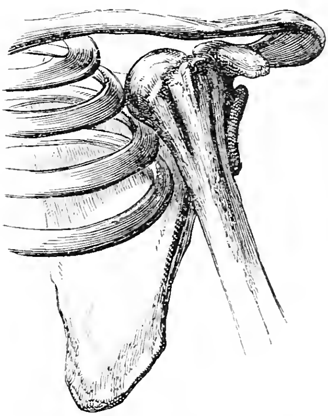
Subcoracoid Dislocations.

When this dislocation has been produced, the anterior portion of the capsular liagament is lacerated. The humeral head slips through this rent and is brought to a standstill upon the inner surface of the neck of the scapula beneath the coracoid process, or exceptionally, as far back as the subscapular fossa. Subcoracoid dislocations may be produced secondarily from the subglenoid variety by spasmodic contraction of the clavicular portion of the great pectoral and coraco-brachialis muscles, or during attempts at reduction.

FIG. 299.

Subcoracoid dislocation of left shoulder. (STIMSON.)

FIG. 300.



Subclavicular dislocation of head of humerus. (GROSS.)

Subclavicular Dislocations.

In this form of luxation the dislocated bone extremity rests upon the chest immediately below the clavicle, and is covered by the pectoralis major and minor muscles. (Fig. 300.)

The acromial and spinous portions of the deltoid, the inner fibres of the coraco-brachialis, and the short and long heads of the biceps muscles are all very tense, whilst the teres major and minor are correspondingly relaxed.

Subspinous Dislocations.

This dislocation is one of rarity. The head of the displaced bone is to be found posterior to the glenoid cavity upon the dorsum of the scapula immediately subjacent to its spine.

The supraspinous and subscapular muscles are either torn or extremely tense, as are also, but in less degree, the long head of the biceps and the clavicular portion of the deltoid.

FIG. 301.

Subspinous dislocation of head of humerus. Front view. (ERICHSEN.)

FIG. 302.

Subspinous dislocation of head of humerus. Back view. (ERICHSEN.)

FIG. 303.

Subspinous dislocation of head of humerus. (ERICHSEN.)

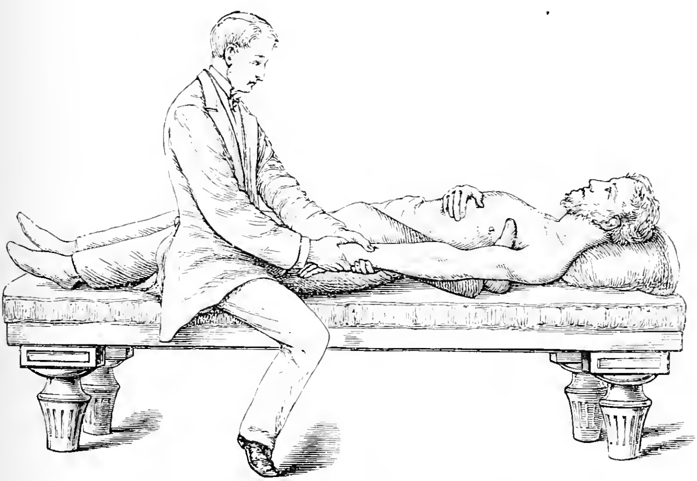
SYMPTOMS AND DIAGNOSIS.—For purposes of diagnosis ether should unhesitatingly be administered if any doubt persist. In the following table, modified and adapted from Agnew, are given the symptomatology and differential diagnosis of dislocations of the humerus.

Downward Dislocation. (Subglenoid.)	*Forward Dislocation.* (*a.* Subcoracoid form.)	*Backward Dislocation.* (Subspinous.)
1. Shoulder *extremely* flattened.	1. Shoulder flattened, but *not extremely* so.	1. Shoulder moderately flattened.
2. Acromion very conspicuous.	2. Acromion prominent.	2 Acromion moderately prominent.
3. Depression below *entire* arch of acromion.	3. Depression greatest at *posterior part* of arch of acromion.	3. Depression greatest at *anterior part* of arch of acromion.

Downward Dislocation. (Subglenoid.)	*Backward Dislocation.* (*a.* Subcoracoid form.)	*Forward Dislocation.* (Subspinous.)
4. Elbow projecting from side.	4. Elbow projecting from side.	4. Elbow at side of body, and arm thrown forward.
5. Axis of humerus directed *below* glenoid cavity.	5. Axis of humerus *anterior to and below* glenoid cavity.	5. Axis of humerus directed *behind* glenoid cavity.
6. Inability to place hand of injured side upon sound shoulder, or upon top of head.	6. Inability to place hand of injured side upon sound shoulder, or upon top of head.	6. Ability to place hand of injured side upon sound shoulder and upon top of head.
7. Presence of hard, hemispherical tumor in *axilla.*	7. Presence of hard, hemispherical tumor in *axilla, but higher* than in subglenoid.	7. *No hard, round tumor in axilla,* but one *present below spine of scapula.*
8. Pain and numbness in arm and fingers.	8. Pain and numbness in arm and fingers *very marked.*	8. Great pain in shoulder; little in arm; no pain or numbness in fingers.
	(*b.* Subclavicular form.) Differs from subcoracoid as follows: Acromion *exceedingly* prominent. The round, hard tumor is *immediately below clavicle.* Elbow directed *backward.* Otherwise identical.	

TREATMENT.—The anæsthetic state to the point of muscular relaxation should, as a rule, be secured before attempts at replacement are undertaken. Reduction is always to be accomplished by manipulation if possible, and it will be found an exceedingly unusual dislocation of the humerus that

FIG. 304.



Reduction by foot in axilla. (ERICHSEN.)

cannot thus be replaced. In using this method the governing principles which have been already set forth are to be employed for the various humeral dislocations as follows: For the subglenoid variety the forearm is flexed upon the arm to relax the long head of the biceps. The elbow

is then grasped, and the arm raised by abduction to the side of the patient's head to relax the deltoid and supraspinous muscles. Now the forearm is supinated to relax further the long head of the biceps. Whilst the arm is held in this position by one hand the surgeon places his other upon the prominent humeral head in the axilla, and as the arm is drawn outward to a right angle with the body, lifts the head into its socket.

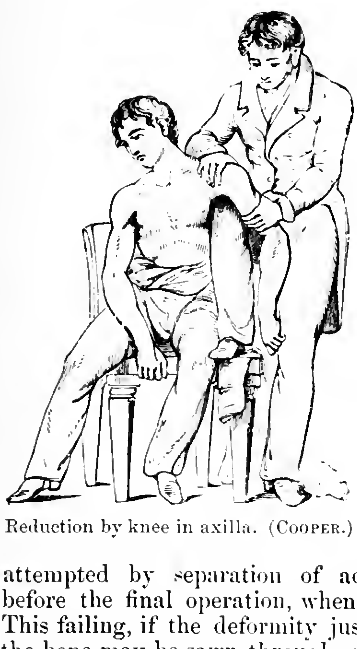
Subcoracoid and subclavicular dislocations are reduced in a similar manner, save that after elevation the arm is to be rotated *outward* before being carried down, that the spinati and teres minor muscles may be still further relaxed.

In dealing with the subspinous variety the arm after being carried by extreme abduction to the side of the head is rotated inward to relax the subscapularis, when the bone may easily be replaced by direct pressure from the fingers during adduction. Manipulation failing, the elbow should be grasped and drawn forcibly upward, while at the same time downward pressure is made upon the shoulder by the other hand. Next the surgeon may stand behind the patient's couch, place his foot upon the shoulder, and make rocking to-and-fro traction and rotation.

If even after this manœuvre the dislocation persist, the surgeon must place his unbooted foot in the axilla for counter-extension and make forcible traction upon the arm.

Other methods of reduction are: by right angle traction, using for counter-extension either the bootless foot upon the chest-wall, or a sheet wound around from the opposite side; by bending the arm down over the knee acting as a fulcrum in the axilla; by placing an air-bag or other pad in the axilla and bandaging the lower arm as closely to the side as possible, which has proved successful, if kept up for days, even in seemingly hopeless, acute, or ancient cases; and lastly by force in the direction opposite to that of displacement. After replacement the arm must be kept in a Velpeau or other similar bandage for a week, and great care must be exercised in its use for a much longer period.

Fig. 305.

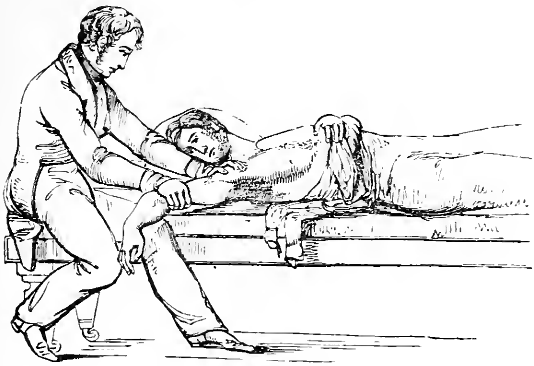


Reduction by knee in axilla. (Cooper.)

Treatment of old humeral dislocations is always attended by great danger of serious accident. Unless contra-indicated by the history, a luxation of the humerus is scarcely ever too old to try reduction upon. But if the history indicates great inflammation and the likelihood of arterio-venous adhesions, the deformity had best be let alone or treated by other means than reduction. If determined upon, reduction must be attempted by separation of adhesions repeated a number of times before the final operation, when manipulation and force are employed. This failing, if the deformity justifies so severe a measure, the neck of the bone may be sawn through, and a false joint established, or its head exsected. Various accidents frequently occur during forcible treatment

of these dislocations, consisting of rupture of vessels, nerves, muscles, or of the neck of the bone itself, and abscess. Wounds of the bloodvessels may be apparent at once by the sudden formation of a fluid tumor in the axilla, or may announce themselves later in the shape of formation of an aneurism or varix. If the artery is torn the wrist pulse is absent, and

FIG. 306.



Reduction by upward traction. (COOPER.)

probably the rapidly formed tumor in the axilla will have pulsation and bruit. Tumors appearing in the axilla at any time after a dislocation of the humerus should excite suspicion and always be auscultated before any operation upon them is undertaken. Only general principles can be given for the treatment of these accidents. If the artery be torn, ligation of the subclavian or pressure thereupon whilst the tumor is slit open and the torn ends each secured, is recommended. Venous rupture can be dealt with in the same manner, or, if possible, by simple pressure. Rupture of nerves may be repaired by their secondary suture. Fractures and ruptures of muscles often prove advantageous from the subsequent relaxation and formation of an artificial or false joint, but motion after fracture must be very guarded lest the vessels be torn by sharp edges or spicules—a far from imaginary danger.

Conjoint Dislocations of Radius and Ulna.

Conjoint dislocations of the radius and ulna take place at the elbow, and in either of four directions: backward, forward, inward, and outward (or laterally). The backward dislocation is much the more common, usually being produced by indirect violence acting through the forearm when the elbow is extended. The bones are thrown in various positions under and behind the condyles of the humerus, and further drawn up by action of the triceps. The capsule is torn and the arm rigidly flexed at about a right angle, although occasionally some flexion and extension, or even lateral motion, may be present. The forearm is shortened and the biceps and brachialis anticus are very tense. Great pain is apt to follow any motion.

Usually the diagnosis is palpably evident, but in case of doubt anæsthesia will quickly make it certain as well as allow thorough replacement.

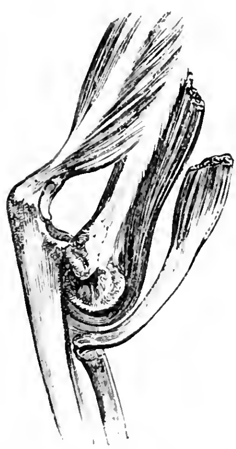
This is to be accomplished by making traction upon the forearm and backward pressure upon the lower end of the humerus by a hand or by

FIG. 307.

Backward dislocation of radius and ulna. (LISTON.)

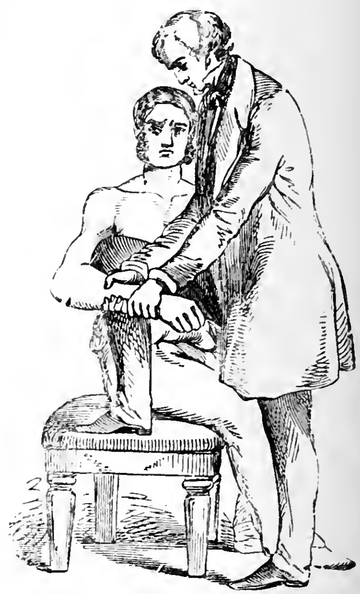
the knee, or the latter may be employed as a fulcrum around which to bend the forearm. When by one of these methods the bone is brought into position the forearm is flexed and thus retained for two or three weeks; then passive motion is instituted. Stiffness need not be anticipated in dislocations of the elbow.

FIG. 308.



Backward dislocation of radius and ulna. (GROSS.)

FIG. 309.



Reduction of dislocation of radius and ulna backward. (HAMILTON.)

Dislocations of the Radius and Ulna Forward.

Dislocations of the radius and ulna forward are unusual without fracture, being produced by direct violence. The forearm is supinated and lengthened, and at a right angle with the arm.

Treatment consists of forced flexion and extension, and counter-extension, or flex and press down upon the forearm.

Lateral displacements of the radius and ulna are rarely complete. They are unmistakable and treated by moderate extension and direct pressure.

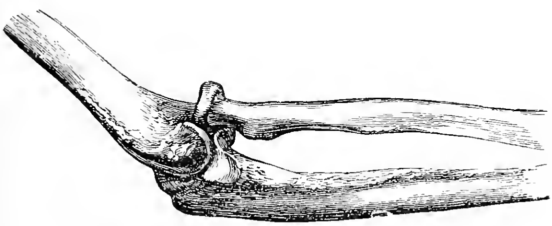
Divergent Dislocations of the Radius and Ulna.

Divergent dislocations of the radius and ulna occur, but are very rare. The bones are both dislocated but do not accompany each other. There are two varieties, the antero-posterior in which the ulna is thrown behind the humerus and the radius in front, and the transverse where the ulna is displaced to the inner side behind the epitrochlea and the radius to the opposite side of the humeral condyles. They are to be diagnosed and treated upon general principles.

Dislocations of the Radius.

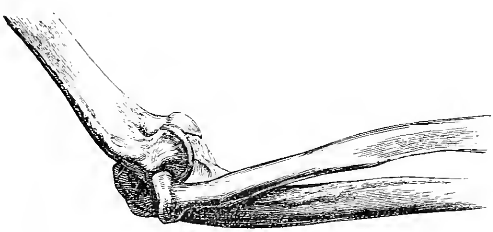
In luxations of this character the head of the radius is thrown from its annular ligament and socket, either forward, outward, or backward. The former direction is taken most frequently. The head is absent from its

Fig. 310.



Backward dislocation of the head of the radius. (Gross.)

Fig. 311.



Forward dislocation of the head of the radius. (Gross.)

normal position and present in a new locality, but the other bones of the elbow are in proper position.

Reduction is often very difficult, but to be attained usually by extension and counter-extension in the direction of dislocation plus direct moulding pressure. Retention after reduction is frequently impossible, but fortunately no great deformity or loss of function ever results if dislocation persists. An anterior angular splint and direct compress must be kept on for three weeks.

Dislocations of the Upper End of the Ulna.

Dislocations of the upper end of the ulna take place in a backward direction as a result of indirect violence. The injury is a very common complication of high radial fracture.

FIG. 312.

Dislocation of upper end of ulna. (COOPER.)

The radial head remains in position, but the ulnar extremity is displaced beneath the condyle of the humerus; the forearm is rigidly fixed at a right angle and pronated. Reduction is accomplished by placing the knee in front of the elbow and making right angle traction upon the forearm and direct pressure upon the displaced end of the ulna. This failing the forearm should be hyperextended and traction made upon it, thus converting the ulna into a lever of the second class, which brings the coronoid process over the condyles of the humerus.

Dislocations of the Lower End of the Ulna.

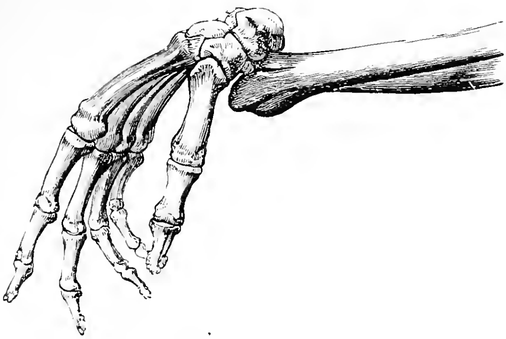
Dislocations of the lower end of the ulna, from its articulation with the radius, take place in either forward, backward, or inward direction; the forward variety being induced by violent supination of the forearm, and the backward form by forcible pronation. Reduction is easily accomplished by fixing the radius and then restoring the ulna to proper position by direct pressure. Antero-posterior splints should be kept on from three to four weeks.

Dislocations of the Carpus.

This dislocation almost never exists without fracture. The direction of displacement is either forward or backward, and is to be diagnosed by the abrupt angle formed by the displaced carpus and the extremities of the

radius and ulna, and by the relation of the former to the processes of the latter, more especially to the styloid process of the radius. Restoration is effected by extension and backward and forward motion of the hand.

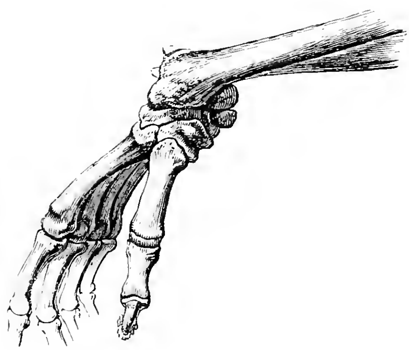
Fig. 313.



Backward dislocation of carpus. (Fergusson.)

Dislocations of individual bones of the carpus occur in an upward direction and have been twisted out of place. Manipulation and direct

Fig. 314.



Forward dislocation of carpus. (Fergusson.)

pressure will usually reduce them, but failing in this they should be excised through a sufficient incision. A pad, palmar splint, and bandage must be applied and worn for about a week.

Dislocations of the Metacarpal Bones.

Dislocations of the metacarpal bones are not uncommon, in direction observe either an upward or backward direction, and are easily reducible by the usual method of extension and pressure.

Dislocations of the Phalanges of the Hand.

Dislocations of the phalanges of the hand are of common occurrence, usually taking place at the metacarpo-phalangeal junction. They are, as

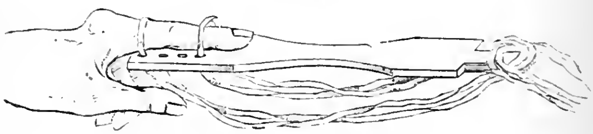
a rule, difficult neither of recognition nor treatment; simple traction by the hand of the surgeon, perhaps assisted by a clove hitch about the in-

FIG. 315.

Extension by Indian puzzle. (BRYANT.)

jured finger, or by the Levis or "Indian puzzle" apparatus, usually sufficing for restoration.

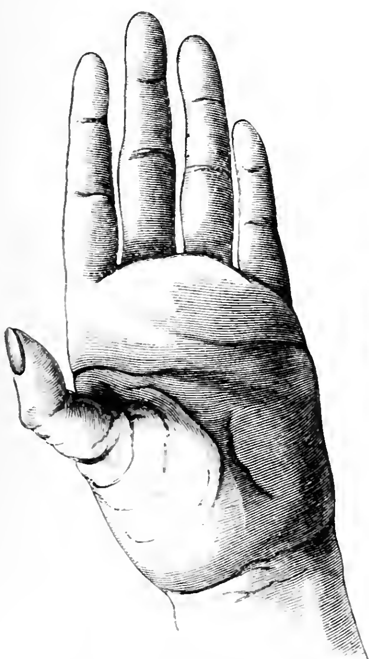
FIG. 316.



Levis's extension apparatus.

But at times one of the displaced bones becomes entangled, and then skilful manipulation, or even division of the constricting band, will become necessary. Especially is this true of backward dislocations of the proximal phalanx of the thumb. In this luxation the head of the metacarpal bone may slip through the in-

FIG. 317.



Dislocation of proximal phalanx of thumb backward. (ASHHURST.)

FIG. 318.

Backward dislocation of proximal phalanx of thumb, showing metacarpal head thrust through and held by heads of short flexor muscle. (AGNEW.)

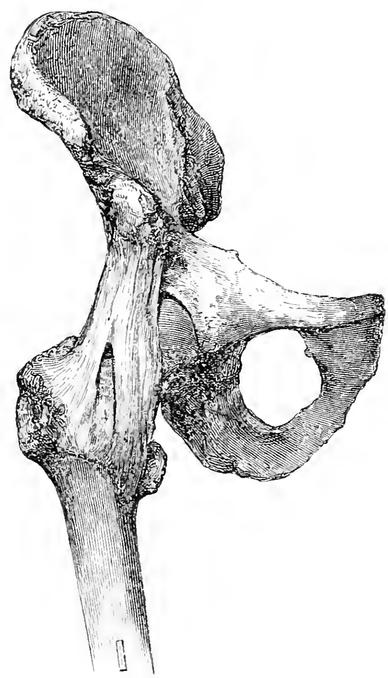
terval between the two heads of the short flexor muscle, when forcible reduction becomes impossible.

Reduction must then be accomplished by manipulation as follows: extend the thumb upon the wrist until its tip points to the elbow, when the end of the phalanx will press upon and separate the then relaxed heads of the short flexors; then place a finger behind the phalanx to prevent its head slipping upward, and bring the thumb down to its proper position. This manœuvre failing, the restricting tendon must be divided by subcutaneous or open incision. The parts, in any case, must be kept at rest by a spica of the thumb or splint for three weeks. Old dislocations of this joint may demand, should all of the above measures fail and disability justify, the excision of the metacarpal head, or even amputation of the member through the metacarpo-phalangeal joint.

Dislocations of the Femur.

Luxations of the femur take place at the hip-joint, and comprise about nine per cent. of all dislocations. The head of the femur, after leaving the acetabulum, may occupy any position about the joint, depending upon the direction of the applied force, the position of the limb at time of accident, and the extent of ligamentous and muscular laceration. As a rule, regular dislocations may be said to occur when one or both branches of the ileo-femoral ligament remain intact, and the irregular or anomalous when that ligament is extensively or completely lacerated. The *rôle* of this ligament in the production and treatment of hip dislocations is of extreme importance. It originates upon the front and outside of the anterior inferior spinous process of the ilium, crosses downward, spreading over the anterior surface of the hip-joint, and divides into two portions; the outer to be inserted into the trochanter major, and the inner into the trochanter minor. This ligament being extremely powerful, usually prevents the head of the femur quitting the acetabulum save in a posterior or lateral direction.

FIG. 319.



Ileo-femoral ligament. (BIGELOW.)

Femoral dislocations are always caused by indirect violence, and may be classed in two great divisions: those where the head is thrown anteriorly to the glenoid cavity, or forward dislocations, and those where it is displaced posteriorly, or backward dislocations. Of each of these classes there are

two principal varieties, which will be described, also a great number of unpractical subdivisions which will not be separately considered. Backward dislocations comprise more than three-fourths of hip displacements. They are divided into those directly backward into the sciatic foramen (ischiatic), and those backward and upward upon the dorsum of the ilium (iliac). The upward variety is most common of all hip dislocations, whilst the directly backward dislocation ranks second.

Of forward dislocations we have the forward and downward into the thyroid foramen, and the forward and upward upon the pubis, or pubic dislocation; the latter being rare, but the former ranking third of all hip displacements. The capsular and round ligaments are invariably torn, and the femoral vessels may be injured in forward, and the sciatic nerve in backward dislocations.

Femoral dislocations are invariably to be first treated by manipulation under profound anæsthesia, but should this method fail, then extension and counter-extension in the line of dislocation may be judiciously employed; but should both measures prove inefficient after several trials, at intervals, incision and division of the restricting tissues, section of the neck, or even excision of the head, should receive consideration.

Posterior or Backward Dislocations.

When these dislocations occur the capsule is ruptured posteriorly upon its outer aspect, and the head of the bone is shot in a backward or upward and backward direction.

Fig. 320.

Backward and upward (or iliac) dislocation of the femur. (Cooper.)

Backward and Upward (Iliac or Dorsal) displacements take place when the limb is abducted and forcibly rotated inward, or by a force applied from below when the legs are crossed. Simple inward rotation, however, may prove sufficient for its production.

Symptoms.—The thigh is somewhat flexed and adducted, the knee of the injured thigh is slightly above and in front of its fellow, and is in contact with the lower and inner portion of the opposite thigh. The foot is forcibly inverted and the ball of the great toe touches the inner portion of the opposite instep. The injured hip is exceedingly prominent, whilst the head of the femur can usually be felt upon the dorsum of the ilium. There is shortening of the injured limb to the extent of from one to two and a half or three inches, according to the height of the head upon the ilium; flexion and extension are moderately interfered with, but the motions of adduction and abduction are almost impossible. Numbness or tingling of the sciatic distribution may or may not be present, but in any case always is moderate.

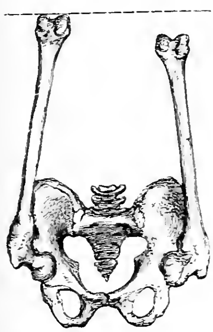
Backward (Ischiatic) dislocations occur whilst the thigh is at right angles with the pelvis and is abducted and rotated inward; the head of the femur is displaced directly backward and comes to a standstill in the sciatic foramen. Portions of the glutei, gemelli, and obturator externus muscles are usually lacerated by the head in transit.

SYMPTOMS.—The thigh is slightly flexed, inverted, and adducted; the knee touches the opposite limb at the inner and upper margin of the patella.

The extremity of the great toe of the injured side just touches the metatarso-phalangeal articulation of its fellow. Shortening never exceeds half an inch, and may even be lacking. Its presence is best demonstrated, as suggested by O. H. Allis, if the thighs be flexed to a right angle with the pelvis and the condyles of the femurs compared.

The hip is somewhat prominent. Numbness, tingling, or palsy of the sciatic distribution may be very marked. The head of the femur is lower and less prominent than in the upward and backward displacement, and the psoas and iliac muscles being tense the trunk is thrown slightly forward. Rectal or vaginal examination may clear up a doubtful diagnosis by demonstrating the head in the sciatic foramen.

FIG. 321.



Allis's test for shortening in backward dislocation of femur.

FIG. 322.

Backward (ischiatic) dislocation of the femur. (COOPER.)

Treatment of Posterior Dislocations (Iliac and Ischiatic).

Reduction can almost always be accomplished by manipulation. The patient should be etherized to relaxation and placed flat upon his back. The surgeon then grasps the leg at the foot and knee, flexes the leg upon the thigh and the thigh upon the abdomen; then adducts the limb and rotates it outward, carries it to the sound side, sweeps it outward across the abdomen, and brings it out straight, when the head will return to the socket, perhaps with a very audible snap.

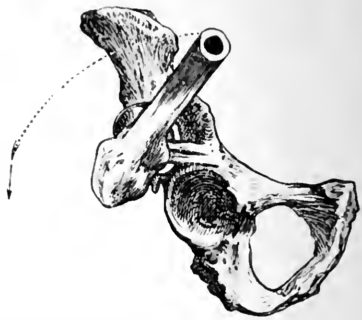
It will be observed that during these manipulations the ileo-femoral ligament is relaxed by flexing the thighs, which also in the simple backward dislocation frees the head from possible entanglement with the tendon of the obturator internus; that external rotation and circum-

duction winds the outer branch of the ileo-femoral ligament around the neck of the fermur and thus carries the head over the acetabular rim and into normal position. Extension and counter-extension in the line of dis-

Fig. 323.

Reduction of backward (iliac and sciatic) dislocation of the femur. (Bigelow.)

Fig. 324.



Mechanism of reduction of backward dislocations of the femur. (Agnew.)

location may be judiciously employed should manipulation fail, but if both prove inefficient after several trials at intervals, open arthrotomy, or section of the neck or even excision of the head should receive consideration.

Anterior or Forward Dislocations.

Forward and downward (thyroid or obturator) dislocations result from the application of force when the limb is abducted; the inner and posterior portions of the capsular ligament are torn and the head of the femur is thrust into the thyroid foramen and rests upon the obturator externus muscle.

Symptoms.—The limb is lengthened from one to one and a half inches, abducted, and the heel is somewhat raised when the patient stands, The toes point forward and may be everted; the hip is flattened and the trunk is inclined forward and to the injured side. The femoral head can be distinctly felt below the horizontal ramus of the pubis. These symptoms are to be interpreted as follows: abduction is due to tension of the glutei muscles and to the tenseness of the inner branch of the ileo-femoral ligament; the body is inclined to relax the stretched psoas magnus and iliacus muscles.

Treatment must be conducted whilst the patient is fully relaxed by anæsthesia. Reduction is accomplished by manipulation, exactly as for backward dislocations, save that *inward* rotation and circumduction are here employed.

Thus the psoas muscle and ileo-femoral ligament are relaxed by flexion, and the internal branch of that ligament is wound about the neck of the femur in inward rotation and circumduction, and draws the bone over the acetabular rim into position.

Anterior luxations may be converted into posterior varieties during manipulation, when obviously rotation and circumduction must be made as for reduction of the latter class.

Forward and upward dislocations (pubic) are quite rare and most infrequent of all femoral displacements. Hyper-extension of the thigh,

FIG. 325.

Forward and downward dislocation (thyroid or obturator) of the femur. (COOPER.)

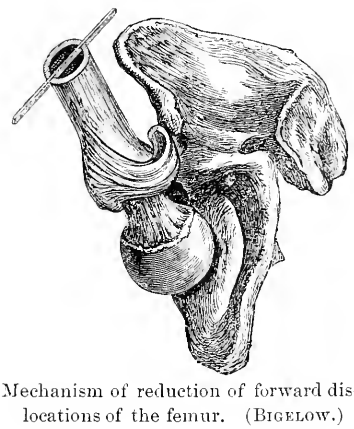
FIG. 326.

Forward and downward dislocation of the femur. (BIGELOW.)

FIG. 327.

Reduction of forward dislocations (iliac, thyroid and pubic) of the femur. (BIGELOW.)

FIG. 328.



Mechanism of reduction of forward dislocations of the femur. (BIGELOW.)

plus an inward rotary motion or a blow upon the foot are the most usual means of production of these unusual injuries. The anterior inner por-

tion of the capsular ligament is lacerated and the head of the femur rests usually upon the pubis in front of the horizontal ramus, although exceptionally it may not be arrested before it has even passed above the pubis.

Fig. 329.

Forward and upward (pubic) dislocation of the femur. (Cooper.)

SYMPTOMS.—The limb is shortened and abducted, the foot much everted, the thigh somewhat flexed, the heel is raised a little from the ground, and the bony head can be felt in front of, or above the pubis. Abduction and eversion are due to tension of the anterior branch of the ileo-femoral ligament and external rotators of the hip. Reduction is attained by the same manipulation as for forward and downward displacement, but flexion and abduction, previous to internal rotation, should be more decided.

Fig. 330.

Forward and upward (pubic) dislocation of the femur. (Agnew.)

Old Dislocations of the Femur.

Femoral luxations are termed old when they have remained unreduced upward of six or eight weeks; reduction has been accomplished many times when the injury had persisted to periods as long as five years. Prudent attempts should be made in any case, regardless of duration, by appropriate manipulation and extension and counter-extension; never, however, employing great force or persistence. If there is a history of inflammation, or if great changes have occurred in the acetabulum or femoral head, manipulative efforts should not be attempted. In any case if deformity and disability are great section of the femoral neck or excision of the head may become permissible. Subtrochanteric section of the femur may, in other cases, be employed with good results, and should fracture occur at or near this point during reduction endeavors it will be fortunate as then passive motion can be kept up and a useful false joint thereby

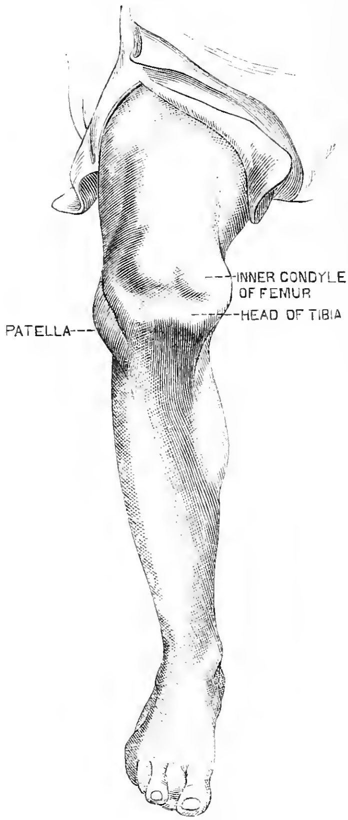
secured. Paralysis of the nerves, or pressure upon bloodvessels may demand operation. The sciatic nerves may be torn during reduction; abscesses may follow any interference.

Dislocations of the Tibia.

Dislocations of the tibia occur at the knee-joint and include 1 per cent. of all dislocations. According to frequency, dislocations occur forward, backward, outward, and inward. Rotary dislocation also, but rarely, is produced by twisting force. Any of the principal varieties may be complete or partial. These injuries, especially if complete, are always serious, and are accompanied by such extensive laceration of ligaments and surrounding tissues and vessels as to demand excision or amputation. The popliteal vessels and nerves are especially liable to stretching or rupture; a clot may subsequently be formed in the artery. The direction of displacement can be recognized with facility by the bony landmarks of the joint, but occasionally, when complications or great swelling have occurred, anæsthesia may be necessary to confirm or make the diagnosis. Shortening will be present if there is overlapping; the part may be either rigid or flaccid. The direction of the foot will indicate rotary dislocation and its direction, should the displacement have assumed that type; the crucial ligaments are almost invariably torn.

Reduction of tibial dislocations is made by traction, extension; and opposite rotation for the rotary variety. Subsequent rest upon a posterior splint for several weeks is essential. Then massage and passive motion. Ankylosis of varying degree is apt to succeed.

Fig. 331.



Roberts's case of unreduced dislocation of patella.

Dislocations of the Patella.

Dislocations of the patella occur with outward or inward displacement of that bone or it may be partially or completely rotated upon its axis, or the latter may occur in conjunction with the former. Outward dislocation, because of the axes of insertion of the patellar ligaments, is most common; all are caused by muscular contraction or direct violence. Complete rotation has twice been reported, and cases of habitual luxation are upon record.

Reduction is effected by rapidly succeeding partial flexions and complete extensions of the leg, plus manipulation of the bone itself and pressure in the direction opposite to that of dislocation. This failing, especially in complete rotations, incision and forcible replacement become necessary.

Dislocations of the Fibula.

Dislocations of the fibula take place at either of its extremities. The bone is forced from its tibial articulations, and forward, upward, or backward displacements are possible. To reduce them the knee is partially flexed and direct pressure is applied, and succeeded by splint or bandage.

Dislocations at the Ankle-joint.

Under this head are included only dislocations of the foot as a whole from the tibia and fibula. These occur backward, forward, and laterally, are most frequently associated with fracture, and as often difficult to differentiate therefrom. Lateral dislocation is almost always associated with fracture of a malleolus. They are to be reduced by flexion of the leg, direct pressure, and manipulation of the foot. Should contraction of the calf muscles constantly reproduce the dislocation and not be controllable by a temporary tight bandage, the tendo-Achillis must be divided.

Dislocations of the Various Bones of the Tarsus.

Dislocations of the various bones of the tarsus are not infrequent injuries, easily diagnosed, and are treated by direct pressure, manipulation, or should these methods fail, by excision of the displaced bone.

The astragalus may be dislocated backward, forward, and outward, or forward and inward, In the former variety the extremity is shortened, the astragulus may be felt in front of one of the malleoli, whilst the foot is extended and twisted to the opposite side. When displacement is backward the foot is extremely flexed, the instep is short, and the heel elongated. The astragalus is to be felt beneath the distorted and tense tendo-Achillis.

Reduction of the forward and lateral varieties can usually be performed by flexion of the leg, traction upon the foot, and direct pressure upon the astragalus. Division of the tendo-Achillis may assist in replacement. Backward dislocations usually prove irreducible, and the bone should be excised at once or at a later time.

Metatarsal dislocations and those of the phalanges of the toes are rare injuries, usually due to crushing force necessitating amputation; otherwise they are to be treated upon general principles of reduction.

Dislocation of Cartilages.

Dislocation of the Costal Cartilages.

Dislocations of the costal cartilages from their various junctions with the sternum, the ribs, and from their points of mutual contact, are possible, but of very infrequent occurrence. Direct or indirect force is always the causative factor.

Symptoms are undue prominence or depression at the seat of articulation, undue mobility, perhaps modified crepitus, pain, or disturbed respiration. These displacements are to be treated by moulding, manipulation of shoulders, forced expiration or inspiration, and after reduction are to be kept in place by means of suitable pads or bandages.

Dislocation of the Ensiform Cartilage.

Dislocation of the ensiform cartilage has only twice been reported; in both instances backward and by direct force. Symptoms were intense gastric pain and vomiting, embarrassed respiration, absence of ensiform upon palpation. Reduce by same methods as for dislocated costal cartilages. If distress is great, and these methods fail, a hook may be inserted through the integument and beneath the tip of the ensiform, when it may be drawn back into position. Or a finger may, through an incision, be likewise hooked under the cartilage. If it cannot be so reduced, or if dislocation is constantly repeated, then nothing will remain but to excise the offending cartilage through a vertical incision of its own length directly over it. The cartilage is then seized with lion forceps, its surrounding attachments carefully divided, it is withdrawn, and the wound sutured with or without a small drain.

As life advances dislocations of chest cartilages give place to fractures, because of the ossific deposits in these cartilages in the aged. Treatment would be the same as that for fracture of the respective proximal bones.

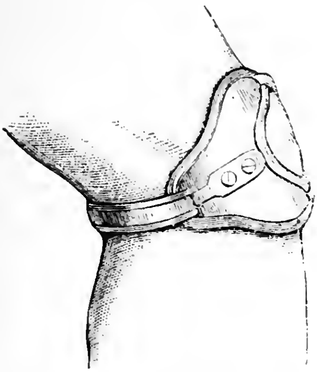
Dislocation of the Semi-lunar Cartilages.

Dislocation of the semi-lunar cartilages is not an uncommon injury; is directly produced by excessive flexion or a sudden wrench, and is almost limited to persons of middle age, especially those who have lax or previously diseased joints. The displacement is generally backward, but may be in the opposite direction. Both cartilages may participate in the dislocation, but more usually the inner one alone is affected. Both knees may be attacked at the same or different times. The etiological factors are a relaxed or previously lacerated knee-joint or crucial ligaments, and excessive flexion; by which the cartilages are forced out of place, perhaps crumpled upon themselves, and become wedged at some point between the femoral condyles and the tibia, stretching or tearing the crucial ligament, if they have not previously been the seat of rupture, and appreciably separating the articular surfaces of the bones entering the joint.

Symptoms.—During stooping, squatting, kneeling, or other excessive flexion of the knee a sudden, intense, sickening pain is experienced in one or both knee-joints. The joint has become locked in a position of extreme flexion and cannot be extended by the patient or by application of force. If predisposition exists the accident may happen to a joint when it is but partly flexed, and when dislocation occurs perhaps throw the person violently down. Compared with the corresponding joint the bones entering it are notably separated, and perhaps the displaced cartilage can be felt in the interval. If the luxation is not soon reduced effusion will take place, inflammation arise, and, possibly, abscess later occur. Even when early replaced, effusion and a sharp synovitis may follow.

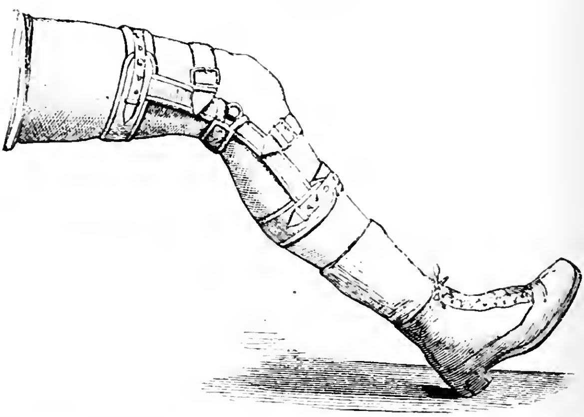
Treatment.—The displacement can almost always be reduced instantly by hyperflexion of the knee over the edge of a table or around a bed-post, followed, while extension is made by a hand behind the calf, by sudden full extension. For this anæsthesia is advisable, as the accompanying pain is great. Following reduction of such cases the joint should be immobilized for three weeks by a plaster dressing or splint that inflammation may be averted and the ruptured ligaments be given a chance to unite. If reduction cannot be thus accomplished after a number of efforts, and in cases where constant recurrence (which cannot be prevented by wearing a tense rubber knee-cap or apparatus which will prevent more than a slight degree of flexion) renders a patient unfit for occupation or enjoyment of life, the following operation, devised by Annandale, should be forthwith performed. Starting, according to whether the internal or external cartilage is affected, upon the inner or outer border of the insertion of the ligamentum patella, an incision is carried upward and inward to an extent of three inches, and downward until synovial membrane is reached.

Fig. 332.



Clamp to prevent dislocations of the semi-lunar cartilage. (Marsh.)

Fig. 333.



Apparatus for cases subject to dislocation of semi-lunar cartilage. (Marsh.)

All bleeding being arrested, the membrane is opened as freely as possible in the line of incision, the offending cartilage caught and pulled to the surface with a blunt hook or forceps, and there sutured by at least three sutures of strong catgut to the fasciæ and periosteum covering the tibial head. The synovial and superficial wounds are then separately sutured and, the limb being extended, a plaster dressing or suitable splint is applied and not removed for several weeks, when gentle passive movements may be made, and at the end of two months the patient may be

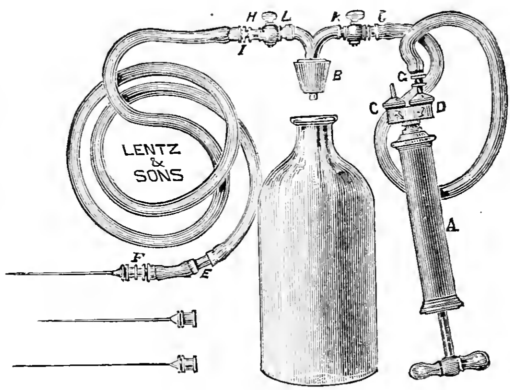
allowed to walk. This operation failing to give relief, the affected cartilage may, through a similar incision, be bodily excised.

Operations upon Joints.

Aspiration of joints is performed by introducing an aspirator needle through the perfectly cleansed integuments, usually at the most prominently distended point, into the joint cavity, and thereby withdrawing the fluid contents.

Washing out or irrigation of joints may be performed either by pumping the irrigating solution through the aspirator needle, and then sucking it out again, by introducing two canulæ upon the same or opposite sides of the articulation and pumping in through one and out through the other, or by making a short incision in the axis of the joint and through it pumping the fluid.

Fig. 334.



Aspiration apparatus.

Exploration of joints is accomplished through incisions exactly similar to those for excision of the corresponding joint, whereby the articulation is laid open to touch and sight.

Erasion of a joint indicates laying it open as for excision, and, if the disease is found to involve simply synovial membrane, ligaments, or superficial cartilages, removal of the affected parts by knife, scissors, or curette without interference with bone, afterward washing the cavity out and treating it as if excised. If thoroughly performed and early enough undertaken this operation yields excellent results.

Excision of Joints.

By excision of a joint is meant the total or partial removal of the articular surfaces and other structures comprising the articulation, or the removal of a portion of bone where ankylosis has taken place. Its object is to secure total eradication of the disease with, in some instances, subsequent bony ankylosis, in others pseudo-arthrosis, or fibrous union.

Contra-indications are: very extensive bone or surrounding tissue in-

volvement, osteomyelitis, advanced age, organic complications such as phthisis, amyloid disease, diabetes or nephritis, great exhaustion. Excision should never be performed for malignant disease of joints or neighboring bones.

Excision may be indicated for:

(*a*) disease,
(*b*) ankylosis,
(*c*) injury.

(*a*) Disease most often demands excision. Chronic synovitis and the varied forms of arthritis furnish a large majority of operations. Bone abscess opening into a joint, and chronic gonorrhœal or rheumatic arthritis occasionally demand it.

(*b*) Ankylosis of certain joints, such as the elbow, knee, or jaw in awkward positions, may justify excision.

Bad positions of the hip and shoulder always, and those of the knee and jaw sometimes, can be better corrected by osteotomy of proximal bones than by excision. When the elbow, shoulder, or maxillary articulations are excised, fibrous union and false joint should be striven for.

(*c*) Excision is unsuited for violent crushing, or very extensive gunshot wounds of joints, or in those where the popliteal vessels are involved. But in certain common shot wounds, fractures into joints, and dislocations, it is eminently appropriate. In these, if bony ankylosis is not desired, often a partial excision, as of one articulating surface, will suffice. Excision may also be indicated for old unreduced or constantly recurring dislocations, as well as for acute joint disease following injury or operation.

Fig. 335.

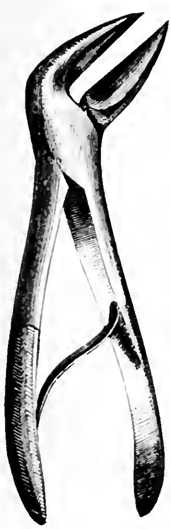
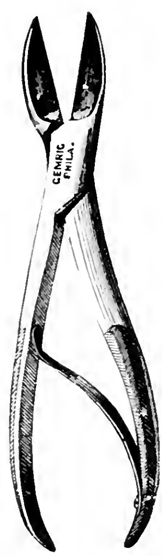


Fig. 336.



Bone-cutting pliers.

Fig. 337.

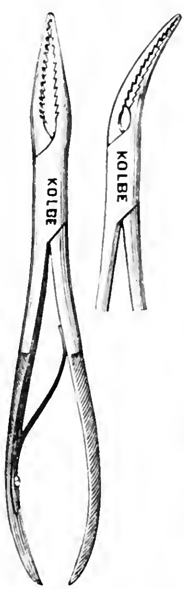
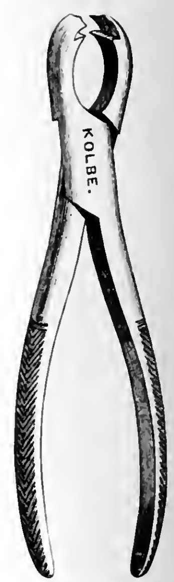


Fig. 338.

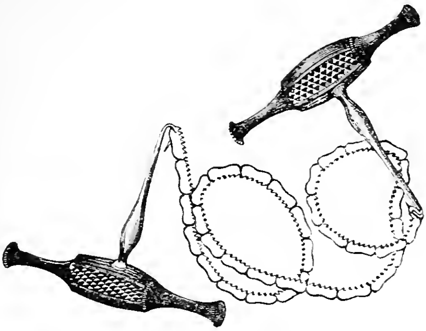


Bone forceps.

Operative Method.—The instruments required for excisions are: ordinary dissecting instruments, retractors, a large-bellied stout scalpel,

cartilage knife, bone raspatory, a strong hernia bistoury to divide ligaments, blunt bistoury, various bone forceps and cutting pliers, a Butcher, metacarpal, Adams, and chain saw, stout bone gouges, a periostal elevator,

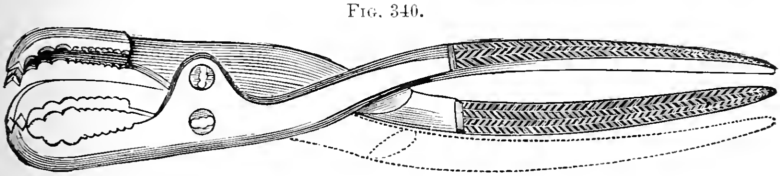
FIG. 339.



Chain saw.

curettes, chisels and mallet, drill, and bone or steel nails. Extra large catgut may also be required for suturing bones together. Avascularity should be secured by Esmarch's rubber band if the joint has not suppurated; otherwise simple elevation of the extremity followed by the

FIG. 340.

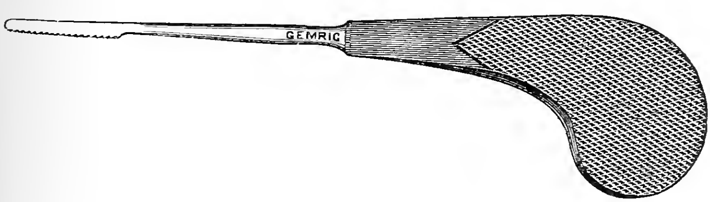


Forceps for grasping large bones.

application of a tourniquet must suffice, for the danger of forcing pus, etc., into the blood-current is considerable.

Incisions should be single, as straight and direct as possible, avoid sinuses, and be kept away from important bloodvessels and nerves. Muscles

FIG. 341.

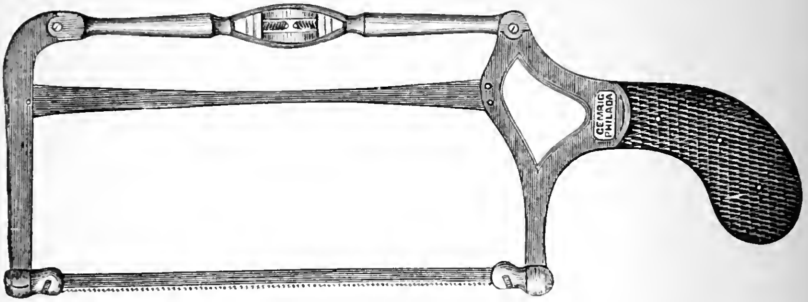


Adams's osteotomy saw.

cles should not be cut if the incision can be carried through intermuscular septæ. The joint having been laid freely open, all diseased tissues are eradicated. So far as the bones are affected they should be removed, but never more, especially in cases of epiphyses, than is abso-

lutely necessary. Experience alone can teach the difference between simple congested or inflamed cancellous tissue and that which harbors infectious disease. Often diseased foci can be gouged or chiselled out of

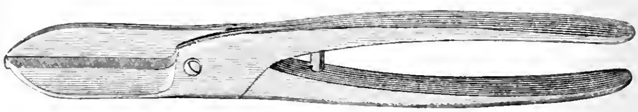
Fig. 342.



Butcher's excision saw.

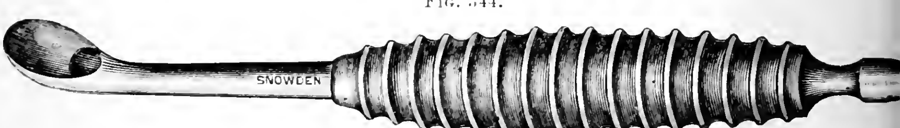
the medulla without further sacrifice of the shaft. In children a stout knife will often do the work of a saw. The value of epiphyses should ever be kept in mind. If subsequent bony ankylosis be desired, cancellated tissue must be exposed upon both surfaces of the joint. All portions of the synovial membrane, other affected tissues, and sinuses, must then be totally eradicated by scissors, curette, knife, or cautery. Sinuses should be bodily excised, when possible. If deep and inaccessible, a curette should be carried into them as far as possible.

Fig. 343.



Butcher's excision pliers.

Fig. 344.



Barker-Willard irrigation curette.

The tourniquet is now removed, and all hemorrhage stopped. Bleeding from bone medulla can be controlled by a few moments' pressure with a finger or pad, or by packing in a small wad of fine catgut and leaving it. Carefully wash out the cavity, insert a good-sized rubber drain in large joints or a hank of catgut into small ones, restore all parts to as near normal position as possible, suture, dress copiously, place the limb upon a proper splint, and always keep it elevated for the first half day or so.

Most joints can be so excised and dressed that but a single dressing completes the cure. The dressing in no case should be changed under three or four weeks or more, unless there are distinct indications therefor.

Where fibrous union or false joint is required, dressings may be changed and motion be commenced in four weeks. When unabsorbable drains are left in, the wounds should always be dressed and the tubes removed not later than the first week.

Some form of mechanical support will be required for a long time after many excisions.

PROGNOSIS.—With modern methods excisions, when early undertaken, have come to be quite safe and successful, and the scope of the operation has become correspondingly extended. Risk of operation increases as the trunk is approached.

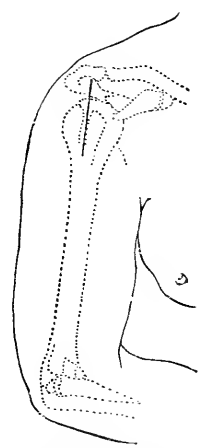
Excision of Temporo-maxillary Joint.

Excision of the temporo-maxillary joint is performed by making a one and a half inch vertical incision downward from a point just behind the middle of the zygoma, but in front of the temporal artery, carrying it down through the masseter muscle, exposing the neck of the jaw, dividing it with Adams's saw or cutting pliers, and then freeing the separated condyle from ligamentous attachments. Simple osteotomy of the neck of the bone is preferable for ankylosis at this joint. Temporary palsy of some of the facial muscles may follow division of the seventh nerve fibres.

Excision of Shoulder-joint.

Make a four-inch vertical incision, beginning at the anterior tip of the acromion process, and carry it downward through an inter-fascicular partition of the deltoid until the capsule is opened and the humeral shaft exposed. Free the deltoid from its capsular attachments. Divide the capsular attachments of the head, and also the tendons inserted into the tuberosities, rotating the arm inward to divide the then tense spinati and teres minor attachments, and outward for the subscapularis. Dissect the long head of the biceps from its groove, and hold it aside. Throw the humeral head outside of the wound by carrying the elbow across the chest toward the opposite side and then pressing it upward and outward. Saw off the head with a Butcher's or other saw, and trim any sharp edges or spiculæ left. If a common amputating saw is used, the soft parts must be protected by a disinfected strip of wood or hard rubber. Remove all diseased tissues, gouge out the glenoid cavity, or, if it is extensively involved, cut it away with pliers. Wash out the cavity, control bleeding, drain, suture, and dress in such position that the cut extremity of the humerus is in the glenoid cavity. That is, get the bone into position, dress and bandage as for fracture or dislocation in the same locality. Redress in about three or four weeks, and then, if the wound is sufficiently healed, commence passive motion, massage, and electricity. A

FIG. 345.



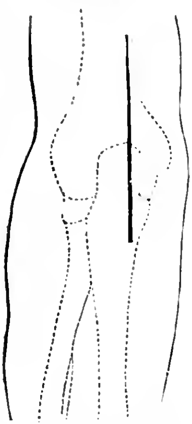
Excision of shoulder-joint. Line of incision.

very useful arm may be looked for; the muscles shorten, and a false joint forms. Abduction will be much impaired, but the forearm will be as good as ever.

Excision of Elbow-joint.

The arm is avascularized by the rubber band or elevation and tourniquet, slightly flexed and brought over a pillow or block with the olecranon looking upward. Incision is begun two inches above the centre of the olecranon and carried vertically downward four inches, bareing the humerus above, the ulna below, and opening the joint in the centre. The articular extremities are then separated from their muscular and ligamentous attachments, great care being observed to dissect the ulnar nerve from its groove on the inner side of the joint and to keep it held out of harm's way during the subsequent manipulations. The nerve is gotten out by slipping a director into the canal from above and dividing the outer wall upon it. Now the olecranon process is cut from the ulna with pliers, the lateral ligaments, if still present, are divided with a strong hernia knife, and by flexing the joint the remaining bones are thrown outside the wound and sawn off. If permissible, not more than the articular surface of the humerus, the olecranon above the coracoid process and the radius above its tubercle should be taken away. The soft parts must be protected whilst the sawing is done. Eradicate all diseased surroundings, stop hemorrhage, irrigate, suture, drain, dress and place the arm upon an obtuse angle splint between pronation and supination to secure greatest relaxation. Catgut drains will often answer here. Re-dress in three or four weeks and commence motion. At the elbow false or movable joint is always desired. A mechanical appliance must usually be worn.

Fig. 346.



Excision of elbow-joint. Line of incision.

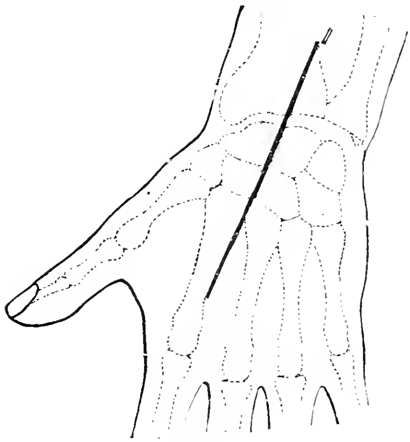
If no more bone than has been indicated is removed the result will be good and the forearm preserve excellent functions. But if more, especially of the radius and ulna is taken away, power of flexion is obliterated by removal of the insertions of the biceps and brachialis anticus, and rotation much interfered with; in fact, above the forearm the member will be useless, although below that point all will continue as before.

Excision of Wrist-joint.

By excision of the wrist-joint is meant removal of the ends of the radius and ulna and of the first row of the carpal bones; and, perhaps, also of one or more of the second row, or even of the metacarpal extremities. Great patience, caution, and anatomical knowledge are here requisite. The parts are rendered avascular and an incision is made beginning at or upon the outer surface of the forearm two inches above the styloid process of the radius at a point just inside the inner margin of the extensor communis digitorum and carried in a downward and inward direction along the margin of that muscle and the tendon of the extensor

indicis, until about the centre of the metacarpal bone of the index finger is reached. The flaps are now well dissected back and all underlying tendons running over the joint freed from their sheaths and held aside by retractors. If the pisiform bone is to be removed the attachment of the flexor carpi ulnaris to it must be divided. Occasionally the extensor carpi radialis longior or brevior cannot be gotten out of the way, so must be divided and the ends marked by threads or otherwise for subsequent recognition and suture.

Fig. 347.



Excision of wrist-joint. Line of incision.

No tendons should be cut unless positively necessary, but when so, any number may be freely divided, marked, and after removal of the bones sutured. All tendons being out of the road, the radio-carpal ligaments are divided, and, by strongly flexing the hand, the radius and ulna are thrown out of the wound. Their under surface is then freed carefully from tendons and nerves and the necessary amount sawn off. The hand is then brought back, the inter-carpal joint opened and the first row of bones excised, either individually or *en masse*, great caution being observed when working near the radial artery.

The second row should likewise be removed if diseased. If required, the metacarpal ends can be cut off best with pliers. The synovial membrane and other diseased structures are then carefully removed, the cavity washed out, hemorrhage controlled, any divided tendons sutured, and a drain, dressing and palmar splint applied. Passive motion of the fingers should be commenced early.

Excision of the wrist is not a favorable operation, and the results are often wretched. Still, if even slight use of the fingers is retained, the patient will value the member much more than an artificial limb. Excision may be performed in apparently hopeless cases, and, should it completely fail, amputation can be done after the member has been given a final chance.

Excision of any particular bone or bones of the carpus may be made by the above (but more curtailed) incision, or by one directly over the affected area.

Excision of metacarpal proximal extremities can be made by a one and a half inch vertical incision directly over the joint, through which pliers cut off the extremity.

Excision of Metacarpo-phalangeal, and Inter-phalangeal Joints.

Excision of metacarpo-phalangeal and inter-phalangeal joints can be performed through a vertical one to two-inch incision upon the upper aspect of articulation. Articulating extremities are separated from their bone shafts by cutting pliers and removed. No drain is required as a rule.

Excision of Hip-joint.

Usual Method.—The patient is turned upon his sound hip, and the operator stands facing the patient's back. Incision is begun one and a half inches above and a little posterior to the great trochanter, and carried down vertically in the femoral axis for a distance of five or six inches. The bone is then exposed for the entire distance. Now the capsule is

FIG. 348.

Excision of hip-joint. Line of incision.

freely opened, and the neck of the femur divided transversely by an osteotomy or metacarpal saw, or, if in a young child, by cutting pliers. The head of the bone is then seized by lion-jaw forceps, the round ligament divided if it still remains, and the separated bone removed. All possible diseased structures are then eradicated, the cotyloid cavity well gouged out and irrigated, all bleeding stopped, a large drain carried to the bottom of the wound, and a copious dressing applied. Outside this, some steadying apparatus, such as a plaster dressing to the whole limb and chest, extension and sand-bags or a side splint must be applied to secure perfect subsequent rest of the involved parts. Lateral pressure upon the wound by

a hip-band or sand-bag is advantageous for a few days after the operation, as also is moderate elevation of the limb to promote muscular relaxation and drainage.

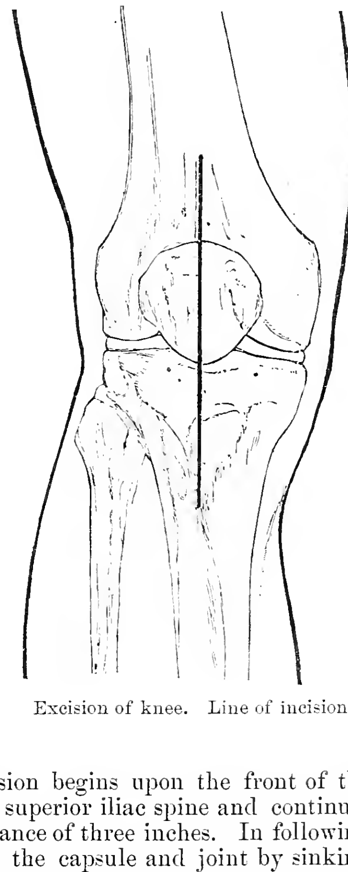
As much more of the femur as may be diseased must always be cut off, after separating the muscular attachments of the trochanters and inter-trochanteric line. By sparing the trochanter minor the psoas and iliacus attachments will be saved. The acetabulum, if diseased, may be cautiously clipped away. A high-heel shoe will be required upon the affected foot, and usually some sort of a leg-brace, having attachment to a body corset; if much of the femur has been taken away, crutches, in addition, will be required.

Second Method.—This is applicable to cases requiring excision in the earlier stages before great bone destruction has taken place or abscesses have burst through the capsule. Incision begins upon the front of the thigh half an inch below the anterior superior iliac spine and continues downward and a little inward for a distance of three inches. In following this line, the knife gains free access to the capsule and joint by sinking between the tensor vaginæ femoris and glutei muscles on the outside, and the rectus and sartorius on the inner side. The joint is then opened and

Fig. 349.

Excision of hip-joint by anterior method. Line of incision. (MacCormac.)

Fig. 350.



Excision of knee. Line of incision.

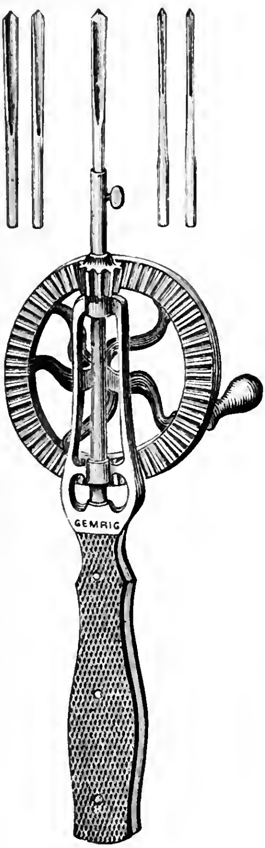
irrigated, the saw introduced, and the femoral neck divided in the direction of incision, and removed after division of the round ligament.

The other steps of operation are identical with the method already described.

Excision of Knee-joint.

This joint should always be brought into as extended position as possible by gradual pulley extension before excision is undertaken; otherwise much bone must be needlessly sacrificed, or too much tension excited in bringing it straight at the time of the operation.

Fig. 351.



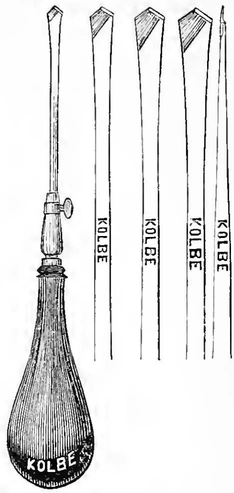
Bone drill

The extremity having been made as straight as possible and avascular, an incision is made from a point in the centre of the thigh three inches above the centre of the patella directly downward to the tubercle of the tibia. (Fig. 350.) The flaps are then held back and the patella is sawn through vertically. Next the quadriceps and patellar tendons are slit to their full extent, the knee still further bent, and one-half of the patella and its attachments pulled to each side as the other bones of the joint are shot out, and the crucial ligaments divided. The necessary amount of the femoral condyles and tibial head (usually about half an inch of each) are then sawn off by either a Butcher saw from without inward, or by an amputating saw in the opposite direction. In the latter case the contents of the popliteal space must be protected by a strip of hard rubber slipped beneath the bones. Then the synovial membrane or diseased cancellous structures are eradicated as usual, all the remaining cartilage cut away, the tourniquet removed, hemorrhage controlled, the bones returned, and the cavity well irrigated. After reduction of the bones, the patella should be dissected out if found diseased. Care must be exercised not to wound the popliteal vessels whilst sawing or cutting away affected soft parts. The bones may be nailed together by steel nails through the skin after the parts are sutured, but it is preferable to drill holes through them and into these insert powerful sutures of chromicized catgut, or through them drive ivory or bone nails, so as to fasten the bones rigidly together. The patella likewise, if not diseased, is sutured, or drilled and nailed, and the split quadriceps and patellar ligaments are united by catgut stitches. Drainage is to be assured by passing tubes through openings made through the skin on either side of the bottom of the wound, and one from above, around the patella into the subpatellar region. Copious dressings and a long posterior splint are then applied, and the limb kept elevated for several days. If the case is successful—that is, bony union and ankylosis are secured—the patient may be allowed to walk in from eight to ten weeks. Shortening is obviated by raising the appropriate heel. No brace will be required unless bony ankylosis does not occur.

Modifications.—If conditions will permit, incision may be made along the inside of the tendons and patella and that bone and its attachments slipped entire to the outer side of the joint when the bones are shot out. Or, if disease is very extensive, incision can be made transverse and the patella sawn through in the same direction. In excision for deformity incision may be in either direction, the flaps separated, and a sufficient wedge to correct deformity taken from the ankylosed bones as a whole. If the case is complicated by contraction of the hamstring tendons, or if there is any tension upon these after operation, they should be divided subcutaneously with a tenotome.

Excision of the knee is almost absolutely safe in properly selected cases and is in them quite certain to yield a good result and a perfectly serviceable limb.

FIG. 352.



Bone drill.

Excision of Ankle-joint.

After avascularization an incision is begun three inches above the external malleolus and carried downward along the posterior margin of the fibula, around the malleolus and forward to within half an inch of the base of the fifth metatarsal bone. The flap is dissected up and the peronei tendons divided. The lower end of the fibula is now cut with saw or pliers and the external malleolus removed, when the astragalus comes into view. The foot is then inverted and the upper surface of the astragalus sawn off, or the whole excised if extensively diseased. Next the end of the tibia is cleared of all attachments and the necessary amount sawn off and removed. If this cannot be readily accomplished through the primary incision upon the inner surface of the foot, another incision running around the internal malleolus and terminating at the cuneiform bone should be made. This flap is dissected back, the tendons, nerves, and vessels are carefully displaced from their grooves and either the tibia shot out or a narrow-bladed saw inserted behind the bone and made to cut from behind forward, the soft parts being meanwhile held aside and protected. The divided portion of tibia is then freed from attachments and extracted through either wound. The leg and foot must afterward be kept upon a right-angle splint or in a fracture-box. If it has been necessary to divide any tendons they must subsequently be sutured.

The results of ankle excision are not gratifying so far as subsequent usefulness is concerned, although the wounds heal well and the parts present a good appearance. Amputation is usually the preferable measure at this joint.

Excision of Metatarso-tarsal, Metatarso-phalangeal, and Inter-phalangeal Joints.

Excision of metatarso-tarsal, metatarso-phalangeal, and inter-phalangeal joints is performed in the same manner as are corresponding excisions of the carpal articulations. But as the digits are comparatively useless, and as deformity following the operation may impede locomotion or produce discomfort, amputation is usually to be preferred to excision.

CHAPTER XIX.

RESPIRATORY ORGANS.

SURGICAL DISEASES AND INJURIES OF THE NOSE.

Foreign Bodies in the Nose.

SMALL stones, beads, and peas are occasionally pushed into the anterior nostrils by children and become fastened in the nasal chambers. Very rarely small seeds or fruit stones may get into the posterior nostrils during vomiting. Such foreign bodies, if allowed to remain, set up inflammation of the mucous membrane of the nose and give rise to an offensive discharge which sometimes is mistaken for grave disease of the nasal structures. Foreign bodies should be removed from the nasal cavities by a small hook, such as comes in pocket cases, or a strabismus hook or some similar instrument. It is usually necessary for the surgeon to illuminate the nasal cavities by means of a forehead mirror. When foreign bodies cannot be removed in this manner they may be washed out of the nostrils by means of a douche. The tube of the douche is placed in the nostril opposite to the one which is occluded, while the patient's head is bent forward with the mouth open. The stream of water then passes around the posterior border of the septum and into the closed nostril behind the foreign substance. This latter is then washed out by the current coming from behind. The foreign body might be pushed back into the pharynx and thus removed, but there is danger of it falling into the glottis and of producing asphyxia. It is better, therefore, to extract such substances from the anterior nares.

Rhinoliths, or nose stones, are concretions of phosphate of lime and mucus which sometimes form in the nose, having for their nuclei small crusts of secretion or foreign bodies. These rhinoliths should be removed in the same manner as foreign bodies. If they are large they can be crushed previously with a pair of forceps.

Epistaxis.

Bleeding from the nose may be the result of injury, or it may occur as a symptom of fibroid or malignant tumors in the nose or pharynx. It occasionally occurs spontaneously, and is due in such cases to congestion of the mucous membrane; often associated at the time with congestion of the brain, cirrhosis of the liver, granular kidneys, heart disease, scurvy, or some of the essential fevers. It is due occasionally to impoverished condition of the blood, and is, as is well known, an early symptom of typhoid fever. Bleeding is said to occur at times from small ulcers upon the mucous membrane.

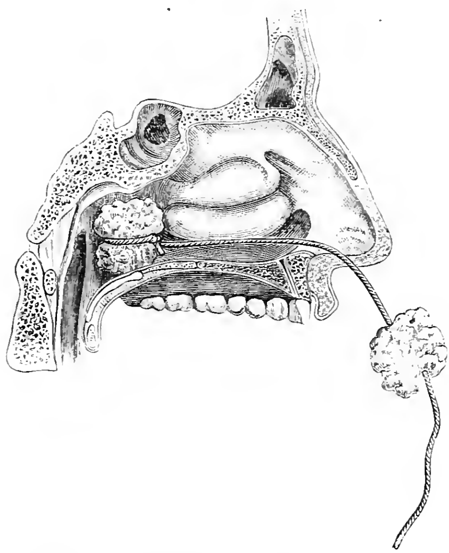
Epistaxis is usually exhibited by an escape of blood from the anterior nostrils, but it may run backward into the pharynx and, getting into the

stomach, be subsequently vomited, giving the appearance of hæmatemesis. It may get into the larynx and be coughed up in a red, frothy state resembling hæmoptysis. Such errors are avoided by examination of the pharynx and fauces in a good light. When the blood comes from the nose it will be seen trickling down the posterior wall of the pharynx.

The treatment of epistaxis involves the consideration of the causes which lead to its occurrence and repetition. The visceral factor in such bleeding should be treated by appropriate medical means.

Traumatic epistaxis, as a rule, ceases spontaneously and needs no treatment. It should be remembered also that in cases of plethora, in which there is congestive headache or other symptoms of cerebral engorgement, bleeding from the nose may be a salutary symptom. Internal remedies, such as gallic acid, preparations of lead, opium and ergot, are given to diminish the tendency to nose-bleeding, but are of little value at the time of its occurrence. In cases of moderate severity the patient should be made to lie down with his head considerably elevated, and with iced

Fig. 353.



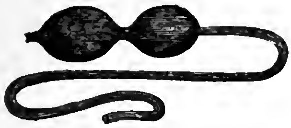
Method of plugging the nares from in front.

cloths applied constantly on the nose. He should then grasp the cartilaginous portion of the nose with his thumb and forefinger in such a way as to keep the nostrils tightly closed. This will prevent respiration through the nose and thereby permit clots to form, thus arresting the flow of blood. The firm pressure by the fingers prevents the access of air and gives an opportunity for the clots to close the bleeding orifice. It has been suggested that pressure with the finger upon the facial arteries will limit the amount of blood flowing through the nose and aid in arresting hemorrhage.

When these simple measures are not sufficient to arrest the bleeding, and the patient shows signs of great exhaustion from the loss of blood, it is proper to plug the nose upon the side which is bleeding. This may

by done by passing a long and narrow rubber bag, from which the air has been expelled, along the floor of the nares so that it will extend from the anterior nostril to the posterior nostril, and inflating it with air. Pressure is thus made upon the walls of the nasal cavities.

Fig. 354.



India-rubber inflating tampon for plugging the nares.

The most effectual means of plugging the nostrils is by means of small pieces of sponge threaded upon a strong cord. The proper method of doing this is to tie a piece of antiseptic sponge, about as large as a good-sized marble, to the end of a piece of silk ligature. The sponge is then pushed along the floor of the naris until it reaches the posterior opening of the nasal cavity. That it has been pushed all the way back can be determined by the length of the string, or by the surgeon putting his finger into the pharynx. When this first piece of sponge has been properly placed, a single string will hang out of the anterior nostril. A similar piece of sponge with a hole in the middle should now be threaded upon this string and crowded back by means of the forceps into the nasal chamber. By thus packing with successive pieces of sponge the whole nasal chamber from the anterior to the posterior opening, bleeding is absolutely prevented by pressure of the sponge completely filling the nasal cavity. The sponge may be allowed to remain in place for from twenty-four to forty-eight hours. If the nose has been thoroughly washed out previously with an antiseptic solution, which of course must be of the non-poisonous kind, and if the sponges and silk are thoroughly antiseptic, there is little danger of putrefaction even when the packing is allowed to remain for a longer time. Usually, however, from thirty-six to forty-eight hours is sufficient to preclude the possibility of recurrence of the hemorrhage. This method is far superior to the use of Bellocq's canula, or any modification of the principle by which a string is brought out of the mouth after being attached to a plug thrust up behind the soft palate.

Nasal Catarrh.

The term nasal catarrh is used to indicate inflammation of the mucous membrane of the nasal cavities. It usually shows little or no ulceration. There are three forms.

1. Simple nasal catarrh, in which there is a thin mucous or muco-purulent discharge without thickening of the mucous membrane and without incrustation of secretion or fetid odor.

2. The hypertrophic form, in which the mucous membrane, especially that over the turbinated bones, is swollen and infiltrated with inflammatory deposits, and in which there is a change of voice and formation of crusts within the nose.

3. The atrophic form, often called dry catarrh, in which there is atrophy of the glands of the mucous membrane, so that the nasal cavities are enlarged beyond the normal condition, and are, of course, larger than is the case during the existence of hypertrophic catarrh, in which the mucous membrane is swollen. The atrophic form is accompanied by great fetor, and seems to be a stage following the hypertrophic condition.

Offensive odor does not seem to be a characteristic of hypertrophic

catarrh, unless atrophy has begun in some portion of the diseased mucous membrane.

The term ozæna is often indefinitely used by surgeons to indicate the existence of a fetid nasal discharge. The term should be discarded, however, because such fetid discharge may occur in atrophic catarrh and in tubercular or syphilitic disease of the nose, as well as from foreign bodies impacted in the nostrils, and from other causes. Since the term ozæna conveys no idea of the pathological condition, it should not be employed. A head mirror and speculum, or rhinoscope, are necessary for the correct determination of these various conditions.

Treatment.—The treatment of nasal inflammations, except when due to syphilis or gonorrhœa, is not very satisfactory, except in the hands of a specialist. Various forms of sprays thrown into the nose by means of an atomizer are valuable; and local treatment of various kinds applied directly to the diseased area are the most efficient means. Constitutional treatment is required to aid these local measures, since nasal disease may depend upon syphilis, tuberculosis, and other conditions leading to bad health; but too much stress cannot be laid upon the necessity for efficient local treatment. Hypertrophied tissue may be removed by the snare, or by the application of the galvano-cautery, or the curette.

Nasal Polyps.

Tumors occurring within the nasal cavities, as sessile or pedunculated masses, are called polypi or polyps. The most common form of polypus is the myxoma, although fibroma, sarcoma, and carcinoma are not very infrequent.

The myxoma is the one meant when the term polypus is ordinarily used. These polypi are soft, gelatinous, semi-translucent, pinkish or yellowish-white masses, which have their attachment to the mucous membrane in the neighborhood of the upper or middle turbinated bones; although they may arise in the antrum and other cavities connected with the nose. They seldom grow from the roof or septum of the nasal chambers, are generally covered with ciliated epithelium, and are multiple, although one or two of the group generally exceed the others in size. In shape, they may vary from the globular to the pyriform or ovoid form.

Symptoms.—The respiratory obstruction due to the condition causes a change in the tone of the voice, giving it the so-called nasal sound. The interference with respiration is increased in damp weather, because the tumor swells from absorption of moisture. An increased feeling of stuffiness in the nose therefore occurs under such circumstances. There is considerable nasal discharge, which is usually not offensive; some frontal headache at times, and, possibly, impairment of the sense of smell. The patient is apt to be continually snuffling, because of the interference with respiration and the flow of mucus. Obstruction of the tear-duct may occur secondarily, and the bones of the nose may be pushed out of place, so that the bridge of the nose is widened by the pressure of the internal tumors. Reflex cough and asthma have been attributed to nasal polypi.

Diagnosis.—Inspection of the interior of the nose will usually make the diagnosis clear, since hypertrophy of the mucous membrane and the other forms of nasal polypi show redness of the surface, very different from the yellowish pearly color of a mucous polypus.

If the tumors occupy a high situation, or if they are not very largely distended by the absorption of moisture, it may be difficult to see them unless a speculum is used in the anterior nares, or a rhinoscope employed for the examination of the posterior nares. The surgeon, by introducing his finger into the mouth and carrying its tip behind the soft palate, may sometimes be able to feel a mass protruding from the posterior nares into the pharynx.

Treatment.—Extirpation of the tumors is the proper treatment, and may be done by the galvano-écraseur, or by avulsion with forceps. The cautery gives less pain and loss of blood, but, in any event, bleeding is not important and the pain need not be severe; the latter can be obviated by painting or spraying the interior of the nose with a solution of cocaine. When the surgeon desires to pull out a myxomatous polypus with the polypus forceps, this instrument should be introduced into the nose in such a manner that the blades open vertically; they should then be pushed up until the gelatinous masses can be seized near their pedicles and pulled from their attachments by twisting. The base may be cauterized with the galvano-cautery or some chemical agent. If the polypus protrudes from the posterior nares, a forceps introduced by the mouth may sometimes be effective.

Intra-nasal fibroid polyps usually arise from the posterior part of the septum or from the superior turbinated bone, and may project into the pharynx, antrum, or pterygo-maxillary fissure. It may occur that the growth will force its way into the orbit, into the cranium, or out upon the cheek, having previously caused absorption of the bony walls of the nasal cavity. Such fibroid tumors may develop in the pharynx and grow into the nasal cavity, or they may extend from the nose into the pharynx, thus obtaining in both cases the name of naso-pharyngeal polypi. When such a growth has obtained considerable bulk it is impossible to determine whether it has had its origin within the nose or in some of the adjacent cavities.

Obstruction due to fibroid polypus is more marked than that due to the myxomatous variety; and the tumor is distinguished by its hardness, redness, and tendency to bleed, and by the fact that its bulk is not changed by damp weather. This form of polypus occurs most commonly in young adults. It is treated by avulsion, ligation, or excision. The galvano-écraseur may be found very useful in removing moderate sized fibroid polyps.

When these growths have obtained considerable size it becomes necessary, if removal is desirable, to separate the nose from the face and turn down the organ, or to gain access to the tumor by splitting the upper lip and turning the ala out of the way. The upper jaw may in other instances be cut loose and turned outward so as to give access to the naso-pharyngeal cavity, or the soft and hard palate may be split with the aid of a saw or chisel. These operations may be undertaken because of the obstruction which the growth causes, or because of bleeding from it which threatens the patient's life. It is justifiable to adopt such radical measures because of the non-malignant character of the tumor; whereas if it was known to be a malignant tumor such operations would perhaps be improper since complete removal would be scarcely possible.

It is stated that such growths sometimes atrophy in patients reaching middle life, and that an operation which simply cuts away a portion of the tumor is preferable to the major operations. Ligation of the two

external carotid arteries has been practised in order to cut off the blood supply to the fibroma within the nose and thus assist in its shrinkage.

Malignant polypi, which are sarcomatous or carcinomatous, increase rapidly, soon infiltrate the surrounding tissue, which undergoes ulceration, and produce involvement of the lymphatic glands. If operation is not undertaken very early it is usually futile. Recurrence is frequent, even after prompt interference.

Adenoid Vegetations in the Pharynx.

In the vault of the pharynx there occur during childhood growths of adenoid tissue somewhat similar to the hypertrophy of the tonsils, which is not uncommon at a similar age. This pedunculated, sessile, or fringe-like growth obstructs the breathing, impairs the quality of the voice, and interferes with the hearing. It is also apt to be associated with nasal and pharyngeal catarrh, or enlargement of the tonsils. The hypertrophic masses may be felt with the finger passed into the pharynx and are apt to bleed when manipulated. The obstruction to respiration causes the child to breathe through the mouth, and leads to symptoms pertaining to mouth respiration. These adenoid vegetations may atrophy as the child increases in age, but it is often necessary to remove them with forceps or curette because they induce deafness. The rhinoscope or head mirror is necessary in these operations. Astringent applications may be of some service in mild cases.

Deformities of the Nose.

Deformity of the nose may be congenital or the result of injury. Occasionally, as a result of injury, a blood tumor forms between the mucous membrane of the septum and the cartilage or bone forming that partition. These submucous collections of fluid resemble abscess of the septum and appear as soft swellings of the mucous membrane. Abscess is similar in appearance, but, as a rule, it follows signs of inflammation. Abscess of the septum should be treated by incision. These bloody extravasations, however, are usually slowly absorbed.

Occasionally bony or cartilaginous tumors grow upon the septum; they are usually near the floor of the nostrils. Such growths may even extend across the nasal chamber and come in contact with the lower turbinated bone, forming a sort of bridge within the nose. It is not unusual for the septal cartilage to be more or less deformed, either congenitally or as a result of traumatism. Such deviation of the septum as well as the cartilage and bone tumors above spoken of, may lead to injurious obstruction which will require operation.

FIG. 355.

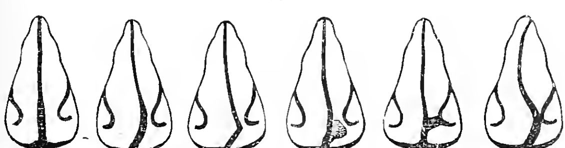


Diagram of deformities of nasal septum from author's "Cure of Crooked Noses."

Deformity due to syphilitic necrosis of the intra-nasal structures is apt to show itself in depression of the bridge of the nose which causes the tip of the nose to appear as a small elevation or knob upon the ante-

rior portion of the face. The entire nose, or a very large portion of it, may similarly be lost from syphilitic ulceration. Portions of the nose may be also removed by wounds, and, therefore, require reconstruction.

Improperly or carelessly treated fractures of the nasal bones and cartilage often give rise to very unsightly deformities of the nose, causing it to have a bent or twisted appearance or to be the site of some unbecoming projection. The surgeon is often required to treat such mal-formations, and may, by judicious measures, restore the deformed outline. It is very difficult, however, to improve the appearance of a nose in which the bridge is sunken as a result of bone disease, or of congenital deficiency in development. A number of more or less complicated operations have been devised for this purpose and are to a certain degree successful.

A cartilaginous or bony tumor growing from the septum should be chiselled or sawed away, as the obstruction leads to breathing through the mouth, a disagreeable tone of voice, and often to nasal catarrh. If the septum is deviated to any marked extent it should be put into place by fracturing it with a strong forceps, or by incisions made into it with a small knife, and subsequently be retained there by pins. If the deviation involves a large portion of the septal cartilage, the cartilage should be made flaccid by a number of incisions cut in it with a stellate nose-punch before it is pinned into its new position. The point of a pin, which should be from one and a quarter to one and a half inches long, is then introduced into the more open nostril, after the septum has been broken or cut and made flaccid, and its point thrust through the anterior part of that portion of the septal cartilage which the surgeon wishes to control and keep in its new relation to the other portions. This part is pressed into the desired position and the point of the pin is then thrust forward through the other chamber of the nose and its point firmly buried in the tissues at the back part of this second nostril. By this device the divided septum is firmly held in its new position as shown by the diagram. The head of this pin will be just inside of the anterior naris and must be allowed to remain for a week or ten days before it is withdrawn. It is often well to introduce a second pin from the external surface of the front of the nose just below the nasal bone. This aids in keeping the septal cartilage and bone in proper place. The second pin should have a flat head so that it may lie close to the surface of the nose and be covered with a small square of court plaster.

Fig. 356.

Author's method of pinning nasal septum.

Submucous resection of the septal cartilage and bony septum is the best method of curing nasal obstruction when due to a limited deflection of the partition between the nares. The mucous membrane is incised and lifted up from the septum, so that a tenotome or small saw can be used to cut out the deflected cartilage and bone. The flap or curtain of mucous membrane is then allowed to drop over the opening in the septum.

If the organ is greatly distorted by reason of old fracture, the soft tissues may, with a tenotome, be pared loose from the bones and the external nasal structures be twisted into place after the septum has been divided and before the pin has been introduced. By proper pinning, the

nose can often be kept in the median line and a fairly normal contour re-established.

This operation is always very bloody and requires etherization. The pinning method is much better than the use of plugs to retain the parts in position, since they do the work more effectually and leave the nostrils free so that an antiseptic solution can be used for washing out the nose during the period of inflammation after operation.

The reconstruction of portions of the nose which have been lost is called rhinoplasty. The most common cause of this condition demanding such operative procedures is loss of the nasal structures from syphilis. A columella may be made by cutting a piece from the centre of the upper lip and turning it up, so that it may be sutured to the septal cartilage and the tip of the nose between the two nares. An ala may be made by turning into the gap a flap dissected up from the cheek or upper lip. A tip of the nose, or even a new bridge may be constructed from the point of a finger which has previously been freshened, sutured to the nose, and kept in that position by gypsum bandages around the arm and head for several weeks.

Total rhinoplasty may be effected by turning down a large flap from the forehead. This is called the Indian method of rhinoplasty in contrast to the Italian method, in which a large flap is taken from the upper arm.

Abscess of the Antrum.

Suppuration within the antrum may be incidental to dental irritation, to tumor, to syphilitic necrosis, etc. One or more of the upper teeth may have their roots penetrating the antral cavity; hence caries, or other disease of such teeth, may lead to inflammation and suppuration of the mucous membrane lining the antrum. Suppuration occurring here, as it does, within a normal cavity, is properly called a purulent effusion. The pus, as a rule, escapes through the nose or through the diseased tooth-socket; hence, symptoms due to retention of pus in the quasi-abscess cavity are not very common. When the pus cannot escape, however, swelling of the cheek, protrusion of the eyeball, occlusion of the tear-duct, stoppage of the nostril, and bulging downward of the hard palate arise from this condition of the antrum, as in tumors occupying it.

Sometimes the walls of the antrum are so thinned by the inflammatory process that pressure upon the cheek may develop crackling similar to that which occurs in cystic tumors of the lower jaw as well as in tumors of the upper jaw. Fluid within the antral cavity may sometimes be diagnosed by percussion on the cheek over the diseased bone, which will develop a percussion note different from that found over the bone on the opposite side. When antral pus does not find vent through a tooth-socket or through the opening into the middle meatus of the nose, pointing may occur upon the cheek or in the roof of the mouth.

The treatment of pus in the antrum consists in puncturing the bone below the upper lip above the canine tooth, or by extracting the tooth, if it is badly diseased, which seems to have its fang extending upward into the cavity of the jaw. The antral wall of the upper jaw is so thin that it can be perforated with a strong knife and treated. The cavity should then be washed out with carbolic or beta-naphthol solution. The opening in the bone should be kept patent by frequent washing by means of a syringe, and, possibly, by the continuous wearing of a metal stile or plug

so as to prevent occlusion of the orifice made for drainage. During eating, a little piece of cotton may be put into the opening in order to prevent the entrance of food, if the retention of a stile or plug is not enforced.

Suppuration, similar to that which occurs in the antrum, may at times occur in the mucous sinus of the frontal bone and require evacuation by trephining the bone at the root of the nose.

Diseases of the Air-passages.

Œdema of the Glottis.

Swelling of the mucous membrane of the larynx or of the folds between the epiglottis and the arytenoid cartilages, due to inflammation or to dropsy, resulting from Bright's disease of the kidneys, may give rise to serious obstruction. This œdema of the glottis, when of an inflammatory kind, may arise from the inhalation of hot steam, the swallowing of acids and other irritating substances, insect stings, or to idiopathic laryngitis.

The treatment of this condition, when asphyxia is too immediate to allow delay for medical remedies, is scarification of the swollen mucous membrane by means of a curved knife introduced through the mouth. The tongue, during the operation, can be held down by means of a tongue depressor, or by the finger of the surgeon. Opening the larynx in the crico-thyroid space may be required to prevent suffocation in severe cases, which the surgeon fears to leave unattended between his visits.

Fracture of the Larynx and Trachea.

The laryngeal cartilages and rings of the trachea may be broken by blows upon the throat, as from a base-ball or in attempts at homicidal throttling. It is usually the thyroid cartilage which is severely fractured. In such injuries the vocal cords may be dislocated and death ensue at once from asphyxia, due to spasm of the glottis. Suffocation may likewise occur from hemorrhage, as a result of laceration of the mucous membrane lining the larynx. Such laceration will probably be indicated by the coughing up of bloody mucus. It is wise to perform tracheotomy in all cases of bad fracture of the larynx and trachea, because of the great danger of sudden death being caused by rapid inflammatory swelling of the intra-laryngeal structures, or to emphysema under the mucous membrane and in the tissues of the throat. The broken cartilage can at times be held in place by the application of adhesive plaster on the outside of the throat. Better apposition, however, can be obtained by cutting down upon the injured cartilages and uniting them properly by means of catgut or silk sutures.

Foreign Bodies in the Air-passages.

Foreign bodies can gain entrance to the larynx and trachea only when the glottis is opened. Contact with the margin of the glottis induces instant spasm, which closes the chink and prevents admission of any intruding substance; hence, foreign bodies can only pass into the air-passages when the glottis is, as it were, surprised. Accordingly, foreign substances usually get into the air-passages when there is sudden, violent

inspiration made at a time when the patient is holding a pebble, a bean, or some such substance in the mouth. Coins thrown up in the air to be caught in the mouth sometimes slip through the chink of the glottis. Food and intestinal worms, which have been regurgitated or vomited into the upper part of the pharynx, may occasionally find their way into the larynx and trachea. Bodies so admitted into the air-tract may be caught between the vocal cords and detained in the larynx, or after passing beyond this point may lie loose in the trachea or even get down into the bronchus. The right bronchus, being in a more direct line with the windpipe than the left, is the tube in which foreign bodies, going lower than the trachea, usually become lodged.

Foreign substances impacted in the larynx at once give rise to violent spasm of the glottis, by which the patient may be immediately suffocated. The lividity of countenance, the gasping for breath, and the shrieks of the patient are followed by foaming at the mouth, insensibility, and sudden apnœa. If the foreign body is small enough to permit the passage of air alongside of it, death may not occur even if it is impacted in the larynx; and the first spasm of respiration, which has just been described, may subside and the patient regain consciousness. Aphonia is characteristic of the impaction of such small foreign bodies in the laryngeal cavity. Spasm of the glottis in such cases occurs at irregular times, in any one of which death may take place. A period of irritation succeeds the obstructive period, and is characterized by pain, coughing, and expectoration of blood-stained mucus. These irritating symptoms are especially prominent if the body has sharp edges, and occur when the foreign body is in the trachea and bronchus, as well as when it is impacted in the larynx. Bodies loose in the trachea may produce violent symptoms. They are liable to be coughed up against the lower surface of the vocal cords and cause spasmodic asphyxia, in which the fatal end may occur, or they may at such times become impacted in the larynx. The symptoms are similar to those already described. The patient is cyanosed, and often is more comfortable in the sitting posture than in the recumbent one. There is, perhaps, feebleness in respiratory sounds on auscultation, which is especially marked on one side of the chest when the corresponding bronchus contains the foreign body. From the occurrence of secondary bronchitis various ralês may be heard in the lungs. In some instances a peculiar whistling or flapping sound may be perceived when the stethoscope is placed over the larynx or trachea, due to vibrations in the current of air produced by the foreign body.

The diagnosis in cases of obscure history may be made by auscultatory signs, and by the fact that foreign bodies are liable to show difficulty in expiration, while croup and other obstructive diseases of the larynx show more difficulty in the performance of inspiration. Laryngoscopic examination will often reveal the presence of a foreign body entangled in the folds of the mucous membrane lining the interior of the larynx.

Treatment.—It is not usual for foreign substances within the respiratory tract to be spontaneously expelled. They may remain for many months, and cause, as a secondary result, hemorrhage, ulceration, abscess, chronic disease of the lungs, and fatal exhaustion. The danger of fatal spasm of the glottis occurring suddenly renders it important that the trachea should be opened, as a precautionary measure, as soon as it is determined that a foreign body is lodged therein. The habit indulged in by some of inverting the patient and slapping him upon the back in order that the offending substance may be expelled is dangerous, and should

never be attempted until after the trachea has been opened, since impaction of the body upon the lower surface of the glottis may cause immediate asphyxia. Anything impacted in the larynx may possibly be removed by the laryngeal forceps with the aid of a laryngoscope. In such instances, of course, tracheotomy is not required, although the surgeon should be prepared to plunge his knife into the crico-thyroid space, and admit air to the suffocating patient, in case his manipulations cause spasm of the glottis.

Where extraction through the larynx and mouth is impossible, the thyroid cartilage should be laid open by a median incision, and carried upward after a puncture has been made in the crico-thyroid membrane. The offending body should then be removed with the least possible laceration of the mucous membrane. A tube should be left in the wound for a day or two until all danger of inflammatory swelling within the larynx has passed. When the body lies in the trachea or bronchus, tracheotomy should be performed instead of laryngotomy, subsequent to which the mucus in the tube should be coughed up by the patient, or sucked out by a syringe or aspirator in the hands of a surgeon. The patient should then be inverted and permitted to cough in the hope that the foreign body may be expelled.

Search for the latter may be undertaken by means of the forceps introduced carefully through the wound. If it is not found the sides of the wound should be stitched to the skin, in order that extrusion may be permitted by subsequent effort at coughing. The patient should be kept in a room whose temperature is not less than 80° F., and the air of which is kept moist by a steam atomizer or similar device. The foreign substance may be so fastened in the trachea or bronchus that its expulsion may not take place until several days have elapsed; at which time it is not impossible that masses of exudate, similar to that found in croup and diphtheria, may also be expelled. When the foreign body has made its exit, it is wise to leave the wound open for a few days lest inflammatory swelling should impede respiration. This is scarcely necessary, however, except in those cases in which the foreign body has become impacted in the larynx, because a considerable amount of swelling may take place in the trachea without obstructing respiration. In rare cases a body lodged in the larynx may be removed better by opening the pharynx between the hyoid bone and the top of the larynx.

Tumors of the Larynx and Trachea.

Tumors of the trachea, as primary growths, are exceedingly rare; but in the larynx various primary tumors occur, and are sometimes called laryngeal polypi. Laryngeal tumors cause symptoms similar to those induced by the presence of foreign bodies in the larynx. The forms most commonly found are papilloma, epithelioma, fibroma, adenoma, and myxoma. These may be pedunculated or sessile, and, if malignant, ultimately involve the lymphatic glands and other structures of the neck.

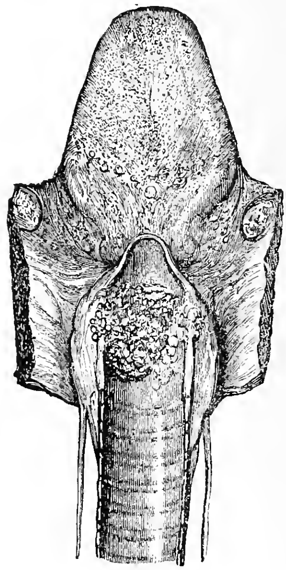
Tuberculosis of the larynx occurs, and at times resembles epitheliomatous disease. Laryngeal tumors grow slowly and attain considerable bulk, for the location, before marked symptoms occur. Their presence is to be detected by the laryngoscope; and, if small, they may be removed by the forceps, snare, cautery, or laryngeal guillotine. In cases where there is great tendency to spasmodic dyspnœa, due to irritation from the intra-

laryngeal condition, precautionary tracheotomy may be required, as when foreign bodies are impacted in the glottis.

When a tumor located within the larynx cannot be removed through the mouth, in the manner described, it becomes necessary to do the operation called thyrotomy.

Thyrotomy, or splitting the thyroid cartilage, in the middle line, is accomplished by incision of the skin over the larynx, by which the thyroid cartilage and crico-thyroid membrane are exposed. The crico-thyroid space is then opened with a knife, and the incision carried upward through the thyroid cartilage almost to its upper margin. It is important not to split the entire cartilage into its two halves, but to leave a portion of it at its upper border intact, in order that the lateral halves may retain their relative position after the tumor has been removed and the sutures applied. During this operation the head of the patient should be thrown well back, in order to make the laryngeal region prominent. When the larynx has thus been opened by external incision, its interior may be examined, and any growth removed by means of forceps and scissors. The cartilaginous tissues are then sewed together with fine catgut, and the external parts sutured and dressed in the ordinary manner. A solution of cocaine should be used to prevent pain during the removal of such growths through the mouth; and it may even give sufficient anæsthesia for the operation of thyrotomy, if it is injected under the skin about the line of the proposed incision.

Fig. 357.



Papilloma of larynx. (Treves.)

A pharyngotomy between the hyoid bone and the larynx may, at times, afford a good route for the extirpation of laryngeal tumors.

Epithelioma of the larynx requires removal of the larynx, called laryngectomy, which should be done in all cases, where the diagnosis is clear, at an early stage of the disease. The larynx is removed by means of an incision in the middle line of the neck from the hyoid bone to the third ring of the trachea. The thyroid body should be drawn downward away from the field of operation. The trachea is then separated from the surrounding structures, and divided transversely at the level of the second ring. The lower portion of the windpipe is next plugged with a tampon of gauze or sponge, through the middle of which passes a large tube by which the air and ether vapor are admitted to the lungs. This plugging prevents the blood flowing from the seat of operation into the air-passages. The larynx must now be freed from the tissues on either side, separated from the hyoid bone above and the pharynx behind, and thus totally removed. The enucleation being thus completed, the radical extirpation of the epitheliomatous tissue is accomplished.

After the superior laryngeal arteries and other vessels have been tied, the dressing, consisting of antiseptic gauze, is packed into the cavity left by the removal of the larynx. Subsequent to the operation the patient

is nourished by enemata or through an œsophageal tube until the wound has cicatrized, while respiration is carried on through the lower portion of the trachea. After cicatrization has been accomplished, an artificial larynx can be adopted and the patient given a certain amount of speech.

Tracheotomy.

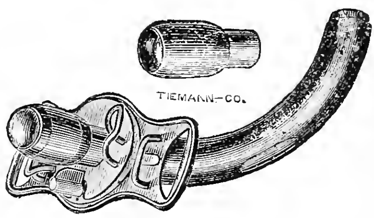
Tracheotomy, or opening of the windpipe, may be required to prevent suffocation in cases of obstruction in the larynx. Such obstruction occurs in the membranous inflammation which takes place in croup or diphtheria, in the occluding swelling of tubercular and syphilitic laryngitis, and in the spasm of the glottis which arises from foreign bodies or tumors in the air-passages. Cicatricial narrowing of the larynx may remain after the cure of syphilitic ulcers, and may cause obstruction demanding tracheotomy. When there is danger of asphyxia, it is wisdom on the part of the surgeon to open the windpipe before the patient's strength has been exhausted by dyspnœa. The operation, if properly done, is not at all a serious one, provided it is performed at a time when the symptoms do not require haste. Many of the accidents which accompany the performance of tracheotomy are due to its postponement until the patient is moribund; hence arise many of the complications to what is otherwise a comparatively simple operation.

When the surgeon divides two or three rings of the trachea, the operation is called tracheotomy; when he divides the crico-thyroid cartilage and the crico-thyroid membrane, or only one of these structures, the operation is termed laryngotomy. If the lower portion of the larynx and the upper part of the trachea are opened, the operation is called laryngo-tracheotomy.

Etherization may be dispensed with in many cases, since the painful part of the operation is in the cutaneous incision, which may be rendered painless by hypodermic injections of cocaine. The sense of pain is practically absent, moreover, in conditions of imminent suffocation from prolonged laryngeal obstruction. I myself, however, nearly always prefer general anæsthesia, especially in infancy, since movement of the child, even if it suffers but little pain, interferes with the operation. When the trachea is to be opened, the patient's shoulders should be raised by thrusting a pillow under them, and the head thrown back so as to put the neck on the stretch. A median incision is then carried from the crico-thyroid space almost to the sternum. Its length depends upon the thickness of the neck and the consequent depth at which the trachea is situated. The veins, swollen because of interference with respiration on account of the patient being in a state of asphyxia at the time of operation, should be avoided if it is practical. Their division, however, is not a matter of serious moment, since they stop bleeding as soon as respiration is reëstablished. The dissection is continued in the middle line, through the deep fascia and between the sterno-hyoid muscles, until the thyroid gland is exposed. The isthmus of this body should be pushed downward, or drawn upward, according as the surgeon intends to open the trachea at the lowest accessible point or in a higher position. When the isthmus, on account of its size, cannot be displaced, a ligature should be tied around it on each side in order to prevent hemorrhage, and midway between these ligatures it should be divided. The windpipe can be recognized by its

white color. A tenaculum is hooked into the tracheal wall to steady it, a sharp-pointed knife then thrust into the windpipe, and two or three rings divided in an upward direction. The incision must, of course, correspond with the median cutaneous incision, in order that the opening in the windpipe may not be closed by the overlying tissue covering it after the surgeon has permitted the trachea to slip from the tenaculum. It is very important that no blood should get into the trachea by the first inspiratory effort after the opening is made, and from thence be carried into the bronchi. Such inhalation of blood may suffocate the patient. In some cases it may be impossible to stop all bleeding before the tracheal cut is made; therefore, the patient should be turned upon his face with his head over the edge of the table, and retained in this position while the opening is made. The blood will then flow out of, instead of settling in the bottom of, the wound. The danger of its being sucked into the air-passages will thus be averted. As soon as the rings have been divided, it is well to thrust a pair of forceps into the trachea in order to hold the lips of the wound apart. In this manner a supply of air is at once given to the patient, and the false membrane or mucus which has obstructed the respiratory passage, can be removed. It may be necessary to wipe out such obstructing material with a feather or camel's-hair pencil passed into the windpipe, or to suck it out by means of a catheter to which an aspirator or a syringe has been attached. In diphtheritic cases it is dangerous and foolish for the surgeon to suck out such membrane with his mouth, since fatal consequences to the operator have often followed this practice. After the trachea has been cleared, a tracheal tube may be inserted in order that the respiration may go on without obstruction from falling together of the lips of the wound. A tracheal tube consists of a double canula, the inner one of which projects at the internal end a little beyond the outer one. The object in having two tubes is to enable the attendant to remove and clean the inner tube, as it becomes plugged with mucus or dried secretions, while he leaves the outer one in the wound in order to make replacement of the inner tube easy.

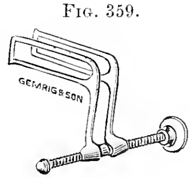
Fig. 358.



Trachea tube, with valve.

The outer tube has flanges upon each side, by which it is held in place by means of tapes and tied around the neck. I prefer, however, to fix these wings or flanges by means of sutures carried through the neighboring skin with a needle. The upper and lower angles of the cutaneous wound may be sutured after the tube has been inserted. There are several forms of tracheal dilators made which are preferred by some operators to the canula.

Fig. 359.



Tracheal dilator.

In diphtheritic patients less skilled nursing is required if, instead of introducing the canula, the surgeon cuts out a small rectangular portion of the trachea and stitches the edges of the tracheal opening to the skin. The tube requires constant watching, and must be kept free from obstruction by dried membrane, secretion, or blood, by the frequent passing of a feather through it. In diphtheritic

cases the inner tube should be removed and cleaned about every two hours, and both tubes should be removed if there are any evidences of serious obstruction.

The patient, whose windpipe has thus been opened, cannot talk unless the orifice in the throat is closed by placing a finger over the tube, or in some way preventing respiration through the anterior orifice. In four or five days after the operation for diphtheria it is proper to make an attempt to dispense with the tube; but if symptoms of laryngeal obstruction still remain, the tube must be reinserted for a few days longer. It is essential that the patient upon whom tracheotomy has been done should be kept in a hot room with a moist atmosphere until the symptoms for which the operation was done have subsided, since bronchitis or pneumonia are very liable to occur from inspiration of cold, dry air. Inhalation of dust should be prevented, if possible, by keeping a piece of mosquito-netting in front of the opening in the throat. This, however, is often impossible in operations for diphtheria where there is frequent necessity for cleansing the tube. The temperature of the room should be kept at 75° or 80° F., and the air should be kept moist by means of an atomizer, or by a wet blanket suspended in the room before a fire. The interior of the trachea and the wound may be mopped with a solution of sodium carbonate in glycerin, or with a solution of pepsin or of trypsin, in order to facilitate detachment of the false diphtheritic membrane. It has been suggested that, after tracheotomy for diphtheria, the windpipe above the seat of operation may with benefit be plugged with sublimate gauze (1: 2000).

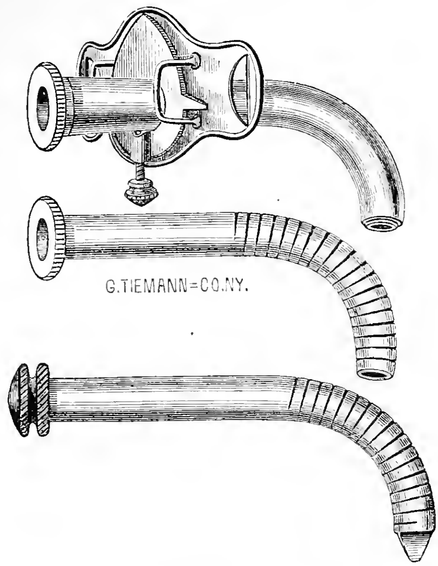
A quick tracheotomy may be done in emergency cases by grasping the larynx between the thumb and forefinger of the left hand and steadying it in this manner, while a rapid incision is made with the right hand in the middle line. In still greater emergency air may be admitted to the lungs by plunging a knife through the crico-thyroid space, which is easily felt as a depression about three-quarters of an inch below the most prominent point of the Adam's apple. An opening thus made will permit air to enter in sufficient quantity until a more systematic operation can be done. I have operated in this manner by means of an ordinary pocket-knife, which is usually always obtainable. Where it is impossible to obtain a proper tracheal tube, a piece of a drainage-tube will temporarily answer the purpose. If the patient has stopped breathing by the time the surgeon has gained an entrance to the windpipe, artificial respiration can possibly be started by blowing into the tube with an ordinary syringe or a pair of bellows. It is wise always to introduce the largest size canula that the trachea will hold. It must not be so large, however, as to strip up the mucous membrane as it is pushed down into the windpipe. A slight alteration as to its length or shape, and also its removal from time to time, are desirable, because the pressure exerted by its internal end may induce ulceration of the lining membrane of the windpipe. The lobster-tail canula, with a blunt pilot for its introduction, is a favorite one with me.

In cases of stenosis of the larynx in which the tracheal tube must be constantly worn, a tube with an opening in the intratracheal portion will enable the patient to expire through the larynx and to talk with comparative ease. If the tube has not this opening, and it fits tightly so that no air passes above the opening, speech is impossible.

The point at which an opening in the air-passages should be made depends upon the condition for which the operation is done. In diphtheria it is best to go as low down as possible; hence, a point below the isthmus

of the thyroid gland is probably the best place under such circumstances. In tracheotomy for chronic disease of the larynx, a high tracheotomy above the thyroid body is efficacious and makes a less difficult operation.

FIG. 360.



Double tracheal tube (lobster tail).

Intubation of the Larynx.

The introduction of a metal tube into the chink of the glottis and its retention there for a period varying from several hours to several days, is called intubation, and is in certain cases a good substitute for the more serious operation of tracheotomy. Though especially employed in cases of diphtheria and œdema of the glottis, it is possible that it may be of advantage in cases of foreign bodies in the trachea, because it will probably prevent fatal asphyxia from spasm of the glottis, due to such foreign body being coughed up against the lower surface of the vocal chords. In such a condition intubation would seem to be of service as a temporary measure until arrangements can be made to open the trachea for extraction of the foreign substance.

Intubation, which is seldom required in adults, is performed with the child held in the nurse's arms without being etherized. A gag is placed between the teeth on the left side of the mouth in order to hold the jaws apart, and an assistant holds the patient's head well back. The surgeon introduces his left forefinger into the mouth and by pressing down the tongue he is enabled to guide the tube with his right hand into the glottis. After it has been so introduced the detachable handle or obturator is removed. The patient then breathes through the tube, which is kept in place by reason of its shape. At the top of the tube is a flange to prevent the instrument slipping into the trachea, and in this flange is a small hole through which a long thread is passed before any attempt at intro-

duction is made. The ends of this thread hang from the mouth and are used to remove the instrument from the pharynx if it is found not to be properly placed when the detachable handle is withdrawn. If, however, the surgeon finds the patient breathing well and the tube properly placed the string is withdrawn and the instrument left in position. If all goes well the tube may be left in position for several days. When its extraction is desired an instrument called by Dr. O'Dwyer the extractor is introduced. This instrument is operated by expanding two blades or jaws after its point is introduced into the calibre of the tube thereby giving the surgeon control of the latter and enabling him to withdraw it quickly. During the introduction and withdrawal of the laryngeal tube respiration is entirely arrested for a moment.

An advantage of intubation is that the consent of the patient's family can be more readily obtained for the performance of the operation than is the case in tracheotomy, which causes bleeding, and therefore seems to them more undesirable and dangerous.

The objections to intubation are that the tube may slip into the trachea, that it may be swallowed, and that food gets into the air-passages, thus causing at times secondary pneumonia. It has been supposed by some that there is danger that the false membrane of diphtheria may be pushed down into the trachea by means of the tube, thereby increasing the respiratory obstruction. This objection, however, applies equally to the insertion of a tube after tracheotomy. Intubation, moreover, does not prevent tracheotomy being performed later, if the necessity for it arises. Attempts have been made to correct the difficulty of feeding after intubation, by attaching a sort of artificial epiglottis to the upper end of the tube.

Intubation is a valuable addition to the surgeon's resources, for which the profession owes much to Dr. O'Dwyer; but is often inferior to the more radical operation, tracheotomy.

Diseases of the Chest.

Contusions and Abscesses.

Pathology and Symptoms.—Contusions and abscesses of the chest wall require no special description other than to say that abscess of the chest wall is occasionally secondary to purulent effusion in the pleural cavity or to abscess of the lung.

Contusion or rupture of the lung tissue may occur without laceration of the pleura. These lesions probably take place because the lung is subjected to blows or concussions when the vesicles are filled with air and the glottis closed, so that the air within the lung tissue cannot be forced out at the time the force is applied. The symptoms of this condition are spitting of blood, diaphragmatic breathing, dyspnœa, cough, bronchial râles, and signs of localized pneumonia, or pleurisy. These symptoms vary with the extent and location of the injury. Emphysema may occur between the lung and the pulmonary pleura, and the air so extravasated may find its way into the mediastinum and upward into the cellular tissue of the neck and back. If the pluera is torn by the injury, blood and air may escape into the pleural cavity and produce hæmo-thorax or pneumo-thorax with their characteristic physical signs.

Pulmonary abscess, or gangrene, and mediastinal abscess are occasional

sequences of lung injuries. Gunshot and stab wounds of the lung are not infrequent; and laceration of the periphery of the lung may happen as a complication of fracture of the ribs. Laceration may occur from puncture of the lung by one of the fragments at the time the fracture of the rib is received, though subsequently no displacement of bone may be discoverable, because the resiliency of the chest wall has brought the fragments of bone into apposition.

The symptoms of such wounds of the pulmonary tissue are similar to those described above as occurring from contusion and rupture of the lung. Subcutaneous emphysema is a very common concomitant of fracture of the ribs when one of the fragments has injured the lung. In such instances the air in the vesicles escapes into the pleural cavity, and then during expiration is pumped through the opening in the costal pleura into the subcutaneous cellular tissue.

It must be remembered that the lung extends downward at the lateral and posterior aspects of the chest to about the level of the tenth rib, while the pleural cavity extends as far downward as the twelfth rib. In a wound of the chest below the tenth rib, therefore, the pleura alone will probably be wounded, and not the lung. If a penetrating wound extends sufficiently deep to traverse the pleural sac, puncture the diaphragm, and enter the abdominal cavity, the organs contained in the abdomen may suffer injury from the bullet or knife in addition to the damage sustained by the pleura. The arching upward of the diaphragm renders it possible for a penetrating injury, even higher than the tenth rib, to produce lesions of both the thoracic and abdominal viscera. When the wound of the chest wall is a comparatively large one, its communication with the pleural sac is often to be recognized by the sucking and hissing sound produced by the air entering the chest during respiration. If a large vessel in the lung is wounded, the bronchial tubes may be so filled with blood as actually to drown the patient.

Pulmonary wounds heal like other wounds if protected from suppuration and putrefaction. The air entering the pulmonary tissue through the trachea is freed from pathogenic germs to a great extent by the filtering process which it undergoes before it reaches the seat of the wound; hence, if the chest wound be kept aseptic, there is little danger of suppuration or septic pneumonia or pleurisy. Protrusion of a lung may occur at the cicatrix of a large wound in the chest wall.

Treatment.—The external bleeding in chest wounds is usually not very severe, and needs no special treatment. If the blood comes from the lungs it will probably be frothy and in greater quantity during expiration than in inspiration. The flow of blood into the pleural sac, which occurs at the same time or before escaping from the chest through the external opening, will probably soon make sufficient pressure upon the lung to stop the bleeding from the pulmonary tissue. The blood so entering the pleural cavity will, if kept aseptic, subsequently be absorbed: if not kept antiseptic, it will break down into pus and cause traumatic empyema.

Severe hemorrhage may supervene from wounds of the intercostal and mammary arteries. The intercostal arteries lie in grooves at the inner and lower margins of the ribs. Hemorrhage from one of these vessels may be stopped by seizing the bleeding point with a hemostatic forceps, which may be left in position for several hours. If arrest of hemorrhage by this means be impossible, the surgeon may perhaps be able to scrape off, with a blunt instrument, the periosteum from the bottom of the inter-

costal groove. This procedure separates the vessel from the bone, and makes its ligation practicable. Another method is to push into the wound the centre of a square piece of antiseptic gauze, and, after distending it like a small bag within the chest, to stuff the pouch so made with small pieces of antiseptic sponge or gauze. By seizing the projecting corners of the square of gauze and drawing the intrathoracic mass firmly against the internal surface of the ribs, pressure is made upon the intercostal vessel and bleeding prevented. Resection of a portion of the rib is seldom necessary to gain control of the vessel from which hemorrhage occurs.

The internal mammary artery runs parallel to the border of the sternum, and from a quarter to half an inch external to this margin. Bleeding from a wound in the internal mammary artery should be treated by ligation or by seizing the bleeding point with a hemostatic forceps, which should then be left in position with antiseptic dressing packed around it.

As a rule, little information is obtainable by the introduction of probes into a chest wound. There is no objection to their use, if they are employed with caution and antiseptically. When the wound is large enough to admit the surgeon's finger, which, of course, must be aseptic, a clear understanding of the nature of the injury is often obtained.

The subcutaneous emphysema which is sometimes present in lung injuries, is recognized by the elastic swelling of the skin, which crackles when pressed upon by the fingers. This tumefaction, which is free from any discoloration such as occurs in cutaneous inflammations, occurs during the first few hours after injury, and afterward subsides gradually without treatment.

Antiseptic cleansing of the wound, the introduction of sutures, and the application of dressings, fulfil the local requirements of the thoracic wounds. In order to keep the chest at rest as much as possible, a firm bandage should then be applied. If suppuration occurs in the pleural cavity, the wound must be thoroughly opened, a drainage-tube inserted, and antiseptic irrigation carried on in the manner discussed under Pleural Effusion. If the traumatic pneumonia is very acute and extensive, venesection may be the only means to preserve life. In other cases secondary pneumonia and pleurisy should be treated by ordinary medical means. The fact that persons subjected to accidental wounds of the chest are usually in a good state of health, and that, therefore, the intrathoracic inflammation is of a sthenic type, indicates that active depressants and purgatives are more often necessary than in cases of idiopathic pneumonia and pleurisy. The diagnosis of the inflammatory conditions within the chest is made, of course, by the ordinary rules of auscultation and percussion.

Bullets and other foreign bodies, unless their location is definitely determined, and found to be accessible to the knife without adding much to the original injury, should be allowed to remain imbedded in the tissues. They often become encysted, and do no harm. If subcutaneous abscess or a sinus indicates their position, the surgeon is justified in undertaking operative search. Under such circumstances I have recently successfully removed, after resection of the ribs, a piece of silver drainage-tube from a young child's chest, where it had been for many months, after having become lost during treatment for idiopathic empyema.

Surgical Treatment of Pleural Effusions.

Aspiration of the pleural cavity or thoracentesis is performed in serous effusion into the pleural cavity (hydrothorax). Incision of the chest wall with the introduction and retention of a drainage-tube into the pleural sac is the proper surgical treatment in cases of purulent effusion into the pleural sac (empyema). In hydrothorax aspiration should be done comparatively early, or as soon, at least, as medicinal remedies do not produce any marked diminution of the quantity of fluid in the cavity. Incision and drainage should be performed as soon as the existence of pus is determined. Aspiration should be done with a hollow needle, and one of the forms of aspirating pumps. Care should be taken that no air enters the chest, and that the lungs and other structures of importance are not injured by the point of the needle. If an aspirator is not obtainable an ordinary trocar and canula is used. A long, rubber tube, however, should be attached during the first flow of serum, immediately after the trocar has been withdrawn, and the end of this tube placed below the surface of a solution of carbolic acid (1 : 20). This precaution is taken to prevent the sucking up of air into the chest when the flow of serum becomes intermittent as the cavity is nearly evacuated.

Thoracentesis does not require general anæsthesia. If the patient is very sensitive to pain the skin at the point of the proposed puncture may be benumbed by a spray of ether or rhigolene, by a hypodermic injection of cocaine, or by the application of ice and salt. The best position for the patient is a semi-recumbent one, which can be changed during the operation to a recumbent one, as he becomes weak. The place to insert a puncturing instrument is in the sixth interspace close above the upper border of the seventh rib and in a line with the middle of the axilla. If careful auscultation and percussion indicate the presence of a localized pleural effusion it may be necessary to select another spot; since it is evident that a cavity containing fluid should be tapped near its lower wall, as this gives the best opportunity for entire evacuation of its contents. As soon as the aspirating needle enters the pleural sac the flow of serum is evident in the glass tube near the needle, or in the bottom of the aspirator. The escape of fluid should be at first somewhat controlled, in order that sudden evacuation of the contents of the pleural cavity may not lead to syncope. It is also wise occasionally to stop the flow for a moment. The occurrence of cough is an indication to desist temporarily; while a discharge of blood through the needle means that the lung, or some vessel, has been injured, and suggests the partial withdrawal of the instrument. When the fluid ceases to escape the operation is concluded by drawing out the needle, unless it is believed from the physical signs that the calibre of the aspirator has been plugged by a mass of lymph sucked into the tube. This complication is, as a rule, indicated by a sudden, rather than a gradual, cessation of the flow. It may be possible, by changing the current in the aspirator, if the instrument permits such a procedure, to force the lymph back into the chest. If this is impossible it may be necessary to withdraw the needle, remove the obstruction, and puncture in a new place.

An antiseptic pad should be placed over the opening after the operation has been performed, and the patient treated by medical means as previously.

Drainage of purulent effusions in the pleural cavity is accomplished by

making a two-inch incision in one of the intercostal spaces just above the upper border of one of the ribs and parallel to the rib. This site is chosen for aspiration and incision, because the intercostal artery runs along the lower edge of each rib. If there is any doubt about the possibility of the space between the ribs being sufficiently large for the surgeon's purpose, the initial incision had, perhaps, better be made in the middle of the intercostal space, rather than close to the upper border of the lower rib. The sixth interspace is, as a rule, a good place for incising the pleura. If there is any evidence of the pus collection being localized the surgeon would naturally make his incision a little below the centre of the area of dulness. As the patient after such an operation lies upon his back, the incision should be made about an inch behind a line downward from the middle of the axilla. The cutaneous incision should be sufficiently large to permit a good size tube to be introduced. If the space between the ribs is not sufficient a portion of the lower rib should be excised. It is not often necessary to remove a section of the entire width of the rib, as a semicircle cut out of the bone with bone forceps or saw will usually give sufficient space for the tube. My own experience has shown that excision of the rib for this purpose is seldom required. If, however, it seems necessary to remove a section of the entire width of the rib the operation should begin by an incision over the middle of the rib; after which the periosteum should be detached and about an inch of the rib sawed out. The intercostal artery in such an operation should be secured before the pleura is opened.

After the dissection has been carried down to the pleura and hemorrhage stopped, if there be any, the pleura should be laid open to the full extent of the external wound. The surgeon's finger can then be inserted, the interior of the chest explored, and any bands of lymph that divide the pleura into separate cavities broken up. Etherization is not essential in this procedure, as the pain is not very much greater than that of aspiration. Local anæsthesia is sufficient. A rubber drainage-tube without side holes and with a calibre of about one-quarter of an inch should be introduced about an inch into the pleural cavity and stitched to the skin by wire or silk sutures. After the extremities of the wound have been drawn together with sutures, a voluminous antiseptic dressing should then be applied. The pleural cavity should be washed out with a solution of carbolic acid (1 : 40), betanaphthol (1 : 4000), salicylic acid or boric acid once in twenty-four hours. These disinfectant solutions are introduced by hydrostatic pressure, obtained by attaching to the drainage-tube another tube or pipe coming from a reservoir held about two feet above the patient. As soon as distention of the cavity by the fluid produces pain the supply-tube should be detached, or the reservoir lowered so that the mingled pus and antiseptic solution may escape. One or two pints of fluid may be introduced into the chest at one injection, and it may be repeated until the outflow is very little stained with pus. Irrigation and drainage in this manner should be continued for several weeks, and should not be discontinued until it is evident that the cavity within the chest has greatly contracted, and there is very little purulent collection. When this occurs the drainage-tube may be withdrawn and the wound allowed to heal by granulation. Too early withdrawal of the tube may permit re-accumulation of the pus, and necessitate a second operation, in order to relieve the septic symptoms which are liable to occur. If the fistulous opening, left after the drainage-tube is withdrawn, remains for many months, further treatment will be required. The condition is, in

rare instances, due to a broken portion of the tube having been left within the chest; but is more apt to happen because the drainage has not been complete, or because the tube has been withdrawn too early. Dilatation of the fistulous track by the introduction of a sponge tent, or a piece of compressed sponge, will often permit reëstablishment of irrigation and thereby induce cure. In other cases it may be necessary to lay open the sinus and resect a portion of a rib in order to obtain free drainage. In some cases healing of the pleural cavity is prevented by the fact that the pus sac will not collapse because of inflammatory thickening and adhesions. Under such circumstances it has been advocated that two or three inches of several contiguous ribs be excised in order that the chest wall becoming flaccid may fall inward, and by coming in contact with the pulmonary wall of the pus sac cause the cavity to become obliterated. In performing this operation it is well to dissect away the thickened costal pleura.

Pulmonary Abscess and Gangrene.

The operative treatment of pulmonary abscess consists in cutting into the lung, after having incised the chest wall and pleura, in order to evacuate the pus confined in the lung tissue. Before such an operation is attempted the most careful physical diagnosis must locate the abscess, and even then it is wise to confirm the physical signs by introducing an aspirating needle or trocar into the lung. When such abscess has been discovered incision of the external tissues and lung is proper, and should be followed by the insertion of a large drainage-tube so that irrigation may be carried on. Excision of a gangrenous portion of the lung has been attempted after opening the chest. The difficulties in diagnosing the position of the gangrenous area are similar to those met in diagnosing the position of an abscess.

Mediastinal Tumors and Abscesses.

Pus in the anterior mediastinum may be evacuated by an incision between the costal cartilages, or by trephining the sternum. Such a possible condition should be given consideration when the surgeon is investigating any obscure case of thoracic disease. Tumors of the mediastinum should also be remembered in this connection.

Diseases of the Neck.

Wounds of the neck should be treated as other wounds. If the trachea or glottis is opened the parts should be brought together and sutured and provision made for drainage. Severe wounds of these structures are often made in suicidal attempts. After the parts have been sutured an œsophageal tube may be required for feeding the patient. If the tongue or epiglottis has been cut loose from its attachments it may cause asphyxia by falling upon the opening of the glottis. Sudden œdema of the glottis may arise as a complication of wounds of the larynx. These complications may render it necessary for tracheotomy to be performed, lest between the visits of the surgeon death may occur from sudden swelling

or rather obstruction of the chink of the glottis. Emphysema of the neck may supervene after such wounds by reason of air escaping from the respiratory tract into the subcutaneous tissue. Diffuse cellulitis of the neck may follow wounds; and septic poisoning, secondary to ulcerations in the mouth or pharynx, to scarlet fever, and to diphtheria, is not uncommon. If the cellulitis assumes a suppurative character free incision to prevent burrowing of pus, and antiseptic irrigation of the cavities in which this is located, are urgently demanded.

Congenital cysts, called hydroceles of the neck, are due to the embryonic clefts not becoming entirely closed. A cavity is consequently left which is filled with fluid. A most common surgical condition, however, in this situation is glandular enlargement due to chronic lymphadenitis. These chronic lymphatic conditions are often the result of tubercular infection and are very liable to become caseous and to break down into puriform fluid. Acute lymphadenitis often arises as a complication from diseased teeth. A lymphatic glandular enlargement situated over the submaxillary or parotid salivary gland sometimes acquires considerable bulk, and is liable to be mistaken for tumor or malignant disease of the salivary gland. Chronic enlargement of the lymphatic glands of the neck should be treated by constitutional remedies, such as tonics, cod-liver oil, potassium iodide, a residence at the seashore, and attention to hygienic surroundings. Locally the treatment should consist of counter-irritation by means of iodine tincture or the ointment of the red iodide of mercury. If after such measures they continue to enlarge it may be proper to excise the glands before they have undergone puriform change. This is desirable because they may become the primary focus from which general tubercular infection may arise. If cheesy or puriform degeneration has taken place it is proper to incise the skin over the softened mass, to scrape away with a curette all the glandular tissue and diseased structure around it, and to dress the wound with iodoform. The depressed scar left by such early incision is less deforming than the irregular and puckered superficial cicatrix which usually remains after spontaneous evacuation of the puriform collection.

The unsightly scars left by the occurrence in youth of such cervical tubercular lesions may be made almost imperceptible by a small plastic operation. An elliptical incision is made around the depressed cicatrix, the skin is dissected loose for some distance on each side, and the edges are then drawn together by sutures over the intervening depressed portion of skin, which has previously been made raw by scraping with a knife edge. Thus the cutaneous structures are elevated to a level with the surrounding skin, and the irregular scar converted into a straight, white line.

Diseases of the Thyroid Body.

The function of the thyroid gland is probably control of the mucinoid substances in the tissues, the regulation of albuminoid metabolism, and the manufacture of blood corpuscles. Its atrophy or entire removal is followed by the condition called myxœdema. (Fig. 362.) In myxœdema the subcutaneous tissue of the patient becomes swollen with mucus. This causes a condition resembling serous œdema, except that the tumefaction is harder. The patient's lips and eyelids become puffy, his mind heavy, his speech thick, the temperature usually subnormal and his intelligence deficient almost to a condition of imbecility. There is loss of the

red and increase of the white corpuscles of the blood. The condition, as far as known, is unamenable to treatment, and is finally fatal. It has been attributed also to changes in the sympathetic nervous system. The defective mental state, called cretinism, found at times with goitre, is probably due to the goitrous affection causing atrophic interference with the function of the thyroid body.

Fig. 361.

Myxœdema. (Treves.)

Bronchocele or Goitre.

Tumors of the thyroid body are usually included under the head of bronchocele or goitre, although in a strict sense the term should probably be employed for enlargements of the gland and not to its infiltration or substitution by morbid growths. The thyroid gland in women not infrequently becomes enlarged from congestive swelling during sexual excitement, pregnancy, and at menstruation. The congestive enlargement so occurring may remain after the causative factors have passed away. The enlargement may include both lobes of the gland as well as the isthmus, or it may involve either lobe or the isthmus alone. At times pulsation occurs in the enlarged gland and is so evident as to simulate aneurism. In one variety of congestive goitre there is protrusion of the eyeballs and irritability of the heart associated with the enlargement of the thyroid body. This condition is a distinct general disease called exophthalmic goitre. In this affection the thyroid gland is swollen, perhaps tender on pressure, and may pulsate. The eyeballs protrude from between the eyelids, as a result, probably, of vascular congestion in the post-ocular tissue, and the heart's action is irregular and feeble. Often there is a murmur heard at the cardiac base. The patient is weak, anæmic, and often subject to anorexia and amenorrhœa. Gradual improvement usually takes place under effective treatment lasting through many months. Cases, however, do at times end fatally.

In addition to the congestive enlargement of the thyroid body, which has been described, simple hypertrophy of the stroma and glandular elements of the organ may occur. Fibrous and cystic changes also take place in this organ, giving a form of goitre corresponding to these alterations. Simple hypertrophic goitre, which is really a fibro-adenomatous change, may follow the congestive form. The patient presents symptoms not unlike those of exophthalmic goitre, except that the ocular and cardiac symptoms are absent. Interference with swallowing and respiration may occur, as the position of the growth may produce pressure upon the trachea and œsophagus. Giddiness may be induced by similar interference with circulation through the large vessels of the neck going to and coming from the brain. In fibrous goitre the stroma of the organ increases more markedly than does glandular tissue, though the pathological alteration is similar in other respects to the simple hypertrophy just described. The thyroid enlargement may be soft and vascular if the growth is rapid, or hard and dense if the change is more chronic in its course. The fibrous form very often affects but one lobe. Its displacing

pressure is very likely, therefore, to cause lateral deflection of the trachea and œsophagus. As the thyroid gland lies below the deep fascia, any enlargement gives rise to injurious pressure upon the other organs of the neck, as has been indicated above. Such pressure is more apparent when caused by a hard, rapidly growing fibrous goitre than when the change is one of the other varieties of bronchocele. Flattening the calibre of the trachea or interference with the normal movements of the tracheal rings during respiration may cause a tendency to dyspnœa. The anatomical attachment of the isthmus of the thyroid body to the trachea causes the gland to rise and fall during swallowing. This furnishes a test in the diagnosis between thyroid enlargement and other cervical tumors. The rise and fall of the mass during deglutition of a little water or food indicate at once the thyroid nature of the growth, since enlargement of the lymphatic glands in the cervical region or other tumors of the neck would in most cases not be affected by tracheal movements. One or more of the acini of the gland may be converted into a cyst or cysts, filled with colloid, serous, or bloody fluid, and constitute the cystic variety of goitre. While the wall of such cysts may be very vascular it may also at times become calcified. In extreme cases the whole thyroid body may be converted into a series of cysts. Goitre is endemic in certain regions of the world, especially in some parts of England and in the Tyrol, and is there often associated with a peculiar deterioration of the brain called cretinism. This has been attributed to the atrophy of the gland which accompanies such thyroid tumors. The different varieties of goitre found in these persons attain at times enormous bulk.

Treatment.—The treatment of goitre differs with the variety of the growth.

The treatment of exophthalmic goitre belongs to the domain of medicine, and consists in the administration of iron, digitalis, and similar remedies.

The treatment of congestive growth is not unlike that of exophthalmic goitre, and consists in the use of digitalis and tonics internally, and counter-irritation by means of tincture of iodine, red iodide of mercury ointment, and similar preparations externally. Ergot, ammonium chloride, and potassium iodide have been advocated in this form of goitre, and are probably of value if given in large doses.

In fibrous goitre the remedies recommended for congestive and exophthalmic goitre may be applied. The benefit obtained, however, is not so evident in this form of bronchocele. When the growth is large and causes pain and other symptoms of pressure, the surgeon should make a cut through the deep cervical fascia, which will permit the tumor to bulge forward, thereby relieving pressure on the important structures beneath it. The incision may be open or subcutaneous, according to circumstances. When this procedure is not effectual, the isthmus of the thyroid gland may be divided in the middle line after two strong ligatures have been applied at each side of the proposed incision to prevent hemorrhage. The repeated injection of alcohol or tincture of iodine, in ten minim doses directly into the fibrous tumor by means of a hypodermic syringe, may diminish the bulk by causing interstitial absorption. Cystic goitres should be subjected to evacuation by puncturing with a trocar and canula, and subsequently to injections of tincture of iodine, tincture of the chloride of iron, or a solution of carbolic acid, if the simple evacuating puncture is followed by reaccumulation of fluid. Care must be taken before injecting these irritants to see whether blood escapes from the

canula after the fluid in the cyst has been allowed to flow out. If blood flows, it is an indication of the possibility of a vein having been punctured, and the point of the canula should therefore be withdrawn a little before the injection is made. It is not safe, however, to inject such irritating fluids into rapidly growing tumors, since they are apt to become violently inflamed. Suppuration is sometimes induced by this method of treatment, due to the invasion of pyogenic germs. Spontaneous abscess of the thyroid gland I have found on one occasion. It should be treated by free incision, in order that the pus and the suppurating tissue may be evacuated and removed. Excision of the thyroid gland has been done in cases where the size of the growth and its pressure symptoms have rendered the operative risk of such an operation justifiable. According to Horsley, excision of more than one lobe must not be performed, since removal of the whole body will lead to myxœdema, and because excision of the isthmus or of one lobe will usually remove the urgent symptoms.

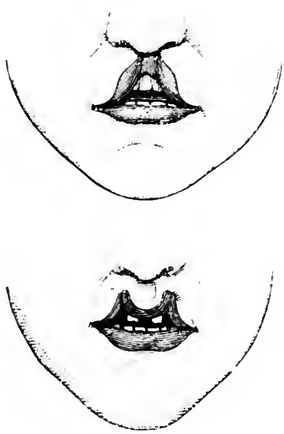
CHAPTER XX.

DISEASES OF THE MOUTH.

Harelip is a term applied to congenital fissure in the upper lip, and may be single or double. The fissure, however, is always a little to one side of the middle line, in a position corresponding with the suture between the inter-maxillary bone and the upper jaw of the corresponding side. When harelip is double, a small portion of the lip lies between the fissures. This central lobule may be very poorly developed; in fact, it may be scarcely more than indicated, thus giving a double harelip the appearance of a single cleft in the median line. The inter-maxillary bone, which carries the incisor teeth, may be separated from the upper maxillary bone of the same side by a cleft which corresponds with the cleft in the lip. This is one of the forms of cleft palate.

Cleft of the palate is a congenital defect, corresponding in character with harelip, occupying the hard or soft parts of the palate, or both. All of these conditions are due to defect in coalescence some time about the ninth week of fœtal life. When the alveolus is cleft and the intermaxillary bone is separated from the other portions of the jaw by such congenital defect, the harelip is often complicated by protrusion forward of the incisor and inter-maxillary structures, which thus extend forward below and in front of the nose as a sort of snout. The nostril on the side corresponding with the harelip is usually broadened and flattened, by reason of the ala being carried outward.

Fig. 362.



Single and double harelip. (Treves.)

Fig. 363.

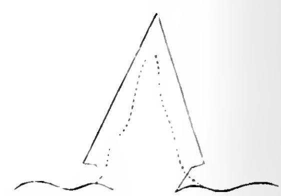


Diagram of incision in operation for harelip.

Harelip, if at all extensive, prevents the infant from sucking well. This circumstance, as well as because it is difficult for the child's lips to be kept at rest after it has learned to speak, renders it proper to operate when the child is between six weeks and three months of age, provided, of course, that the general health is good.

The plastic operation for harelip consists in separating the upper lip

from the gum; in paring the edges of the fissure, and in bringing them together with pin sutures in such a way as to leave no defect in the vermilion border of the lip. Union by first intention is usually obtained, if the operation is well done and the parts so arranged that there is no tension upon the sutures. The child may be held in the nurse's lap with his head placed between the two knees of the sitting surgeon, or it may be placed upon an operating table. Ether is usually given. Compression forceps may be used upon the upper lip near the corners of the mouth to prevent bleeding from the coronary arteries. A straight, narrow knife is then used to transfix the tissues on each side of the cleft and to pare away the borders beginning high up in the nostrils at the angle of the fissure. Sufficient tissue must be removed to make a wide raw surface on both edges of the cleft, so that when the lip is brought together there will be a wide surface of contact to cause union. The strip cut off may be entirely removed or a portion may be retained at the lower part in order to make the free margin of the lip bulge a little when the sutures are placed. It is often well to carry the lower end of the incision a little away from the cleft and then turn the knife toward the middle line so as to leave a tag of tissue covered with mucous membrane.

The accompanying diagram (Fig. 363) shows this incision, which is made in order that the parts which are brought together may pout a little, and prevent the occurrence of a slight notch in the edge of the reconstructed lip.

If this incision is not adopted an incision concave toward the cleft is a good one, because when the concave edges are brought together in a straight line a similar pouting on the margin of the lips is accomplished. A steel pin is then carried through the two portions of the lip and across the gap just beneath the wing of the nose. The flattened condition of the nostril is thus corrected by the same pin which brings the upper part of the gap in the lip together. A second pin is introduced about the middle cleft, care being taken to pass it between the mucous membrane and the coronary artery, in order that the pressure made shall arrest bleeding. The forceps previously applied to prevent bleeding are now removed. Catgut or silk sutures are then carried around the ends of each one of these pins to bring the parts in apposition. A few fine catgut or silk sutures are used along the margin of the lip and upon the internal snrface, in order to bring the mucous membrane into accurate apposition. It is very important that the mucous membrane and the skin should be accurately matched at the muco-cutaneous border as deformity is sometimes produced by having the mucous membrane run up higher on one side of the repaired cleft than upon the other. This is a very unsightly deformity after union has taken place.

The wound is dressed with iodoform and collodion, and the child is fed either at the breast or with a spoon. The pins are taken out upon the third day, although the ligatures are allowed to adhere to the incision, in order to assist in supporting it for a few days longer. The sutures in the mucous membrane may be allowed to remain until the fourth or fifth day. The operation for double harelip is the same. Both clefts are pared and corrected at once, pins being passed through the flattened edges of the lip and through the central lobule if it be large enough to be of any service in filling the gap. The edges of this central lobule are, of course, freshened; but if it is very short it may be necessary to preserve the parings from the lateral margins of the cleft and to use them in filling up the gap below the central portion of the lip when the final sutures are applied.

In case of absence of the nasal columella as a complication it may be wise to turn up the central process of the lip to reconstruct the deficiency in the nose. If the inter-maxillary bone or its alveolar portion protrudes it may be cut away with bone forceps or bent up into place after fracturing its attachments. The vomer, which is sometimes hypertrophied when this protrusion is present, may be retrenched by excision of a V-shaped portion behind the inter-maxillary bone. No attempt is made to correct the cleft in the alveolar process, since the defect is covered by the lip and can be remedied, when the child has reached adult life, by artificial dentures. If union by first intention fails in attempts at curing harelip, it may be necessary to do a secondary operation, in order to get a perfect result.

Cleft Palate.

Cleft palate, which is similar in its origin to harelip, is much more difficult to repair by plastic procedures. The cleft is in the middle line except when it is in the anterior portion of the hard palate, when it may be a little to one side of the middle line. The fissure may sometimes be double in front with the incisive bone lying between the two clefts. It is more common, however, to have only the soft parts of the palate fissured. The operation for the repair of the soft palate is called staphylorrhaphy, while a similar operation on the hard palate is called uranoplasty. Cleft palate interferes with deglutition and speech, because it is usually impossible for the patient to close the posterior nares, which is essential in proper deglutition and speaking. In infants deglutition is often very difficult and the milk is regurgitated into the nasal cavities. These conditions are, of course, greater when the cleft is a large one or involves both the hard and soft palates. In the milder form the child, when beginning to talk, should be especially trained in articulation; as by special development of the muscles he may be able to overcome this defect in speech to a great extent. In more severe cases benefit may be derived by applying to an oral surgeon for the adaptation of an artificial palate. Artificial palates, however, are not sufficiently satisfactory to prevent the adoption by many of operative proceedings in great palatal defects.

Fig. 364.

Fissure of soft and hard palate. (Smith.)

The operation for cleft palate to be most successful should be done before the child has fully acquired the art of speech. About the third year is the proper time. If the patient is young he should be etherized, but in adults the use of cocaine will render general anæsthesia unnecessary. The mouth must be held open by means of a gag. The edges of the cleft, when the fissure involves only the soft palate, should be carefully pared, from the angle of the fissure backward to the free margin of the velum, after which the two sides of the velum must be brought together by silk or wire sutures passed by means of a curved needle.

Before passing the sutures in the operation of staphylorrhaphy it is well, in cases where the cleft is large, to cut the two elevator and tensor muscles of the palate, in order to diminish tension on the soft palate, which is about to be drawn together. This is done by passing a tenotome through the soft palate on the inner side of the hamular process, which can be felt

at the outer side of the roof of the mouth, and carrying the edge of the tenotome upward and then downward, thus dividing the muscles. The flaccid and immobile condition produced by the division of these muscles will prove that the division has been successful. The sutures are then passed and tied. During the after-treatment the patient should be prevented from coughing or talking, and fed on liquid food.

In the operation of uranoplasty, or closure of cleft in the bony palate, two strips of mucous membrane with the underlying periosteum are separated from the hard palate on each side of the fissure and drawn toward the middle line, where they are held together by sutures. The incisions for raising the muco-periosteal flaps are made antero-posteriorly near the alveolar process, and along the edge of the cleft. The flaps are then dissected up, but are left attached at both ends. The middle portions of the strips are then pushed laterally toward the middle line and sutured, while the raw surfaces left by their removal heal by granulation. The soft palate is repaired as described above. Some surgeons prefer to cut entirely through the hard palate with a chisel and displace the detached portions of bone toward the median line. If preferred by the operator, the patient's head may be allowed, in operations on the palate, to hang over the end of the table, so that the roof of the mouth is below the operator. The blood then runs into the nose and does not obscure the field of work.

Operations for the relief of cleft palate, even when extensive, are often quite successful, but at best they make a rather poor substitute for the normal roof of a mouth. Subsequent to their use, careful training of the child in articulation is very important.

Epithelioma of the Lip.

Herpes, ulcerations of the non-malignant kind, and inflammatory fissures or cracks in the lip belong to medicine. Epithelioma, however, is so common an affection, especially among men, and in the lower lip, that it deserves special attention at this point. It is possible that smoking a clay pipe, and similar long-continued irritations, may be factors in the causation of this malignant disease. The upper lip is occasionally the seat of epithelioma. At first the variation from health in the tissues is so slight that it is overlooked; but after a time the patient notices a small hard nodule, which subsequently ulcerates, or an intractable ulcer or fissure appears upon the lip and refuses to heal. Induration about the base of the lesion steadily and gradually increases in size, and a little later involvement of the submaxillary and cervical glands gives evidence that the disease is a malignant one. Epithelioma of the lip does not cause much pain; when ulcerated a thin discharge is secreted. Death may take place from exhaustion or hemorrhage, or from secondary involvement of the internal organs.

Epithelioma and lupus of the lip are sometimes similar in appearance, but the latter does not involve the cervical and submaxillary glands. The diagnosis between epithelioma and chancre of the lip is exceedingly important. Chancre occurs at any age, while epithelioma is more common after the age of forty years. Chancre begins as an ulcer, as a rule, whereas epithelioma ordinarily begins as a nodule. In the syphilitic affection the lymphatic glands are involved earlier; and the sore, even when it attains its maximum, is not so extensive in its progress as the cancerous affection;

and in addition there may be some syphilitic fever. Secondary eruptions may also appear, to assist in the diagnosis; and most important of all, the syphilitic sore promptly yields to mercurial treatment. Epithelioma of the lip, before secondary involvement of the internal organs has occurred, is usually exhibited in the lymphatic glands under and behind the lower jaw. The original site of disease and the involved glands slowly ulcerate, and destruction of the tissues about the mouth and throat is finally very extensive. Labial epithelioma should be treated by prompt and radical operation, except when the disease has extended as indicated; then prolongation of the patient's life by anodynes and supporting measures is all that can be done. Excision of epithelioma of the lip is accomplished by the removal of a V-shaped portion of tissue with the base of the wedge at the margin of the lip. During the operation the lip is held everted by an assistant's fingers, which also press upon the coronary arteries at each side of the proposed incision. The excision should be done soon enough to insure entire removal of the malignant mass. The divided lip must then be brought together by one or two pin sutures, so passed as to make pressure upon the coronary arteries and prevent bleeding. Along the edge and inner surface of the lip the mucous membrane should be united by fine catgut sutures. The wound should then be dressed with a little antiseptic absorbent cotton, held in place by iodoform and collodion painted upon it. It may be necessary in more extensive infiltration to cut a larger portion of the lip away and to construct a new lip from the tissues covering the chin by slipping up one or too large cutaneous flaps.

Excision of a portion of the jaw is required if the disease has involved the bone tissue. Enlarged glands under the jaw and in the neck should be removed at the same operation. The prognosis after excision of epithelioma of the lip is usually quite good, if the portion attacked permits of free removal. If the growth returns, it should be removed a second time.

Tumors of the Mouth.

Tumors of various kinds may be found upon the buccal surface of the cheeks and in the floor of the mouth. The most common form, perhaps, is the cystic tumor, occurring beneath the tongue and usually upon one side of the frænum, to which the term ranula is usually applied. Ranulæ contain a more or less transparent, gelatinous fluid, resembling saliva. They are sometimes dilated ducts of the submaxillary or sublingual glands, and at other times occur as dilatations of the ducts of the mucous glands in the floor of the mouth. True hydatid cysts have been found here, and the bursa above the hyoid bone has been known to become enlarged, and resemble ranula. These cystic tumors are soft, elastic swellings, which gradually increase in size. They sometimes become so large as to push out the tissue of the neck below the jaw and make a distinct bulging upon the exterior of the throat. Adipocere and rice-like bodies have at times been found in ranulæ.

The treatment of these non-malignant growths consists in puncturing the sac so that evacuation of fluid takes place, and then setting up sufficient irritation of the lining membrane to cause obliteration of the cavity. This last object may be obtained by scraping the interior of the sac with the trocar and canula with which its fluid contents have been withdrawn, or by laying open the sac with a knife and mopping

out its interior with chloride of zinc or carbolic-acid solution. Some surgeons prefer to operate by making an opening in the cyst wall, and keeping the orifice patulous by turning a portion of the wall inward and stitching it with its internal surface toward the interior of the sac. A seton may be passed through the sac, so as to evacuate its contents and give rise to plastic adhesion of its walls. Large cysts projecting externally may require to be attacked by incision in the neck. After evacuation, the cavity of the cyst is then stuffed with antiseptic gauze. It is occasionally possible to dissect out the cyst by means of external incision.

Alveolar Abscess.

Abscesses of the alveolar process may be superficial, when they are called gum-boils, or deep, when the pus originates in the tissues around the root of a tooth. Abscesses occurring in the tooth sockets are usually due to disease of the teeth, as, indeed, is usually the case in superficial abscess. The pus in superficial abscess is not confined by bony tissue, as in the deeper form, and is, therefore, the seat of but moderate pain. In those cases in which the pus is confined in the dense walls of the tooth sockets the pain is excruciating, and is only relieved when the pus is evacuated either spontaneously or by drilling the bone or the tooth. Removal of a filling which has been previously placed in a carious cavity in the crown of the tooth by the dentist may afford exit to the confined pus. Escape of the pus gives instant relief from pain. When the pus does not thus find its way through the bone in which the tooth is lodged, it may finally be evacuated alongside of the tooth after it has reached the upper edge of the socket. Occasionally, the suppurative process gives rise to a fistulous opening in the cheek or in the roof of the mouth, and may even cause destruction of the palate bone and penetrate into the nasal cavity.

The treatment of alveolar abscess consists in the use of leeches locally to the gum; painting the gum with tincture of aconite root; the application of heat and moisture, which is best accomplished by the use of a hot fig or raisin applied to the gum; incision of the gum, and, in deep abscesses, boring of the bone or tooth, in order to permit the escape of pus. In many instances the tooth should be seen by a competent dentist, since removal of the filling and treatment of the abscess cavity through the tooth may hasten cure and preserve the structure.

Acute subperiosteal abscess may occur in connection with alveolar inflammation, and lead to more or less extensive destruction of the bone by necrosis. Early and thorough incision is the proper treatment.

Tumors of the Jaw.

Growths involving the alveolar process of the jaw, but not the bone very extensively, have long been given the name epulis. This term, however, should be discarded, since it has no strict definition, and many cases of so-called epulis would be better understood and more effectively treated if called tumors of the jaw and described by their proper adjective as fibromatous, sarcomatous, and carcinomatous. The common growth to which the term epulis is applied is a fibrous mass, usually if not always arising from the periosteum or bone, and presenting itself as a smooth, firm, elastic growth alongside of or between the teeth. It may

become ulcerated. These fibromas are more common in the lower than in the upper jaw, and they appear to be due to the irritation caused by decayed teeth. Such fibromas should be removed by operation within the mouth in order that the scar may not appear upon the cheek. They are ordinarily easily cut away with a strong knife or gouge, though it may be necessary to extract one or more teeth in order to make the extirpation complete. They are not apt to return.

Malignant tumors of the jaw, whether occupying the alveolus, and therefore being a form of epulis, or arising from the central portion of the jaw-bone and gradually extending to the surface, should be removed by very free incision through the soft tissue and bone. Such malignant growths require total or partial excision of the jaw, the amount of bone removed depending upon the time at which the operation is done. In some instances it is sufficient to cut away the upper margin of the lower jaw without making the section complete. Similar tumors affecting the upper jaw may require its complete or partial resection.

Non-malignant growths of the jaws, as has been stated, may require only partial excision of the bone, or possibly may be enucleated without taking away much of the bone tissue. Malignant disease, however, whether it involve the upper or lower jaw, should be removed by very free incisions and by enucleating any of the lymphatic glands which may be secondarily involved. Where it is impossible to get beyond the recognized limits of the disease, operation may be unjustifiable, although some instances seem to indicate that removal of the major portion of the growth by means of a knife and the application of chloride of zinc solution to the surface left may be followed by prolongation of life.

Cystic, as well as solid, growths may develop within the antrum or cavity of the upper jaw bone. Such tumors occasion great deformity as the growth pushes the walls of the antrum into the neighboring fossæ, or outward upon the face. By this means the eyeball may be protruded because the floor of the orbit is raised; the nasal chamber may be occluded by the growth; the hard and soft palate may be pushed downward, and the face may be deformed by protrusion of the cheek. Difficulty in breathing and difficulty in swallowing may result from such antral growths. Cerebral complications may also occur, as well as blindness and profuse nasal hemorrhage. Solid growths in the antrum are to be distinguished from cystic growths by their firmness, and by the fact that in the latter case fluid is evacuated when the antrum is tapped from within the mouth above the canine tooth. Rapidity of growth occurring in persons beyond the middle age and involvement of the submaxillary and other lymphatic glands suggests that the tumor is malignant rather than benign. This diagnosis is confirmed when rapid infiltration occurs outside the bony walls of the antrum, because it indicates that the malignant tumor has involved the bony walls and spread to the soft tissues.

Cystic tumors within the antrum may owe their origin to the abnormal development of a tooth within the antral cavity. Such dentigerous cysts are not uncommon.

Necrosis of the Jaw.

Necrosis of the jaw is not uncommon in those exposed to the fumes of phosphorous acid in the manufacture of matches. It is probable that this disease, called phosphorus necrosis, occurs only when the patient is the subject of diseased teeth. The necrotic portion of bone should be

removed by operation within the mouth so as to avoid a scar. This should not be done ordinarily until the sequestrum has become detached, because it is desirable to retain the integrity of the arch of the jaw-bone which in earlier attempts at removal may be fractured. Where the sequestrum is very large it may be necessary to make an external incision. The application of artificial dentures to the defective bone after the removal of such large portions may give a useful lower jaw.

Actinomycosis is a disease due to a parasitic fungus which has been known to attack the jaws and to be the cause of necrosis. Necrosis also occurs secondarily to some of the essential fevers, and as a symptom of tuberculosis, syphilis, injuries, diseased teeth, and excessive mercurialization. Ankylosis and articular disease of the temporo-maxillary joint have been discussed elsewhere.

Diseases of the Tongue.

When the frænum of the tongue is abnormally short, preventing the protrusion of the tip beyond the teeth, and limiting its movements within the mouth, tongue-tie is said to be present. This condition sometimes prevents a young child from suckling, and in older children interferes with perfect articulation. Tongue-tie, however, does not prevent speech and make a child dumb, as is sometimes supposed by the laity.

When tongue-tie exists to any marked extent it should be remedied by clipping the edge of the frænum with the scissors. The incision should be about one-eighth of an inch deep. The surgeon's finger can then tear the tissue and establish lingual movements. The ranine arteries lie in the frænum close to the lower surface of the tongue. Division of these vessels is avoided by keeping the point of the scissors turned downward. Reunion of the cut portions of the frænum should be prevented by separating them daily with a probe or with the finger. The edges of the slight wound will have cicatrized in four or five days.

Inflammation of the Tongue.

Glossitis, or inflammation of the tongue, may be acute or chronic, simple or specific. Simple or superficial inflammation of the mucous membrane of the tongue occurs in connection with stomatitis or inflammation of the mouth. Stomatitis is applied to inflammation of the mucous membrane lining the cheeks, lips, and other oral structures. It may arise from digestive disorders, the administration of iodine, mercury, and other drugs, and as a lesion of secondary syphilis. Mucous patches and erythema are the pathological conditions of the mouth most prone to follow syphilis. It must be remembered that chancre itself may be found in the mouth. Syphilis may be exhibited by mucous patches or gummy deposits or ulceration in the tongue. General parenchymatous inflammation of the body of the tongue of an acute kind occasionally occurs, and is quite a serious condition. It may be due to wounds or to insect bites, or it may occur without apparent cause. The tongue is swollen and red and shows a smooth surface. Pain, which is great, is perhaps increased during efforts at taking food. The flow of the saliva is abundant and the interference with respiration may be marked. The condition is occasionally followed by sloughing.

Syphilitic glossitis requires constitutional treatment and local stimu-

lating applications. Acute parenchymatous glossitis should be treated by leeches applied under the jaw externally and the use of cracked ice in the mouth, while the patient is nourished with liquid food. If these means do not relieve the swelling and the inflammatory symptoms, incision should be made in the tongue to the depth of one-half inch along each side of the middle line, beginning well back upon the dorsum of the tongue, and extending nearly but not quite to the tip. The relief from tension and swelling given by this incision will usually be immediate. Antiseptic mouth-washes should be freely used thereafter.

Injuries to the tongue and the impaction of foreign bodies in the organ give rise at times to acute or chronic suppurative inflammation or abscess of the tongue. If the puriform fluid lies deeply in the organ the chronic abscess may be surrounded with infiltrated tissue sufficiently hard to cause resemblance to a tumor imbedded in the lingual muscles. Such abscesses of the tongue are treated by incision and the removal of more or less inspissated puriform fluid with the curette. Chronic abscess is probably tubercular in its etiology.

In addition to these forms of glossitis there occurs a chronic superficial inflammation to which the names leucoma, psoriasis, and ichthyosis have been applied.

Epithelioma of the Tongue.

Various benign and malignant tumors may occur in the tongue, but the most common of all is epithelioma, which is a disease with distressing symptoms. It is more frequent in man than in woman, is a disease of rather advanced life, and apparently may at times arise secondarily to superficial glossitis. Smoking, the immoderate use of spirituous drinks and of condiments, irritation from jagged teeth, as well as syphilis, have been suggested as possible predisposing causes.

Epithelioma of the tongue appears usually on one side of the middle line toward the root of the organ. Superficial ulceration with indurated base and edges is an early evidence of the disease. The pain is at first slight, but the discomfort increases during eating and other movements, until it becomes very great. The saliva flows more freely and the breath becomes fetid. The floor of the mouth and fauces become involved, as do also the lymphatic glands below the angle of the jaw. Slight or profuse hemorrhage may occur. Impaired nutrition, due to the difficulty in feeding and the swallowing of foul secretions, is soon evident. If one of the lingual arteries is opened by ulceration, fatal hemorrhage probably supervenes, while death may also occur from septic pneumonia, due to inhalations of the secretions from the malignant growth.

The diagnosis between epithelioma of the tongue and ulcerative syphilitic gumma is at times difficult, but the doubt can easily be cleared up by the use of mercury and potassium iodide in full doses. Specific disease under this treatment will soon show evidence of improvement.

The only effective treatment for epithelioma of the tongue is early and complete removal of the whole tongue and of any lymphatic glands below the jaw, which may be involved. Where the disease has progressed to the involvement of the floor of the mouth before the surgeon is consulted it may be doubtful whether operation is justifiable. In such a case ligation of both lingual arteries may possibly retard the development of the growth, and excision of a portion of the lingual nerve on the side affected may relieve pain. This nerve can be felt in the mouth lying underneath

the mucous membrane at the angle of the lower jaw, vertically below the second lower molar tooth. An incision through the mucous membrane will enable the operator to take up the nerve by means of a hook and to excise a portion of it. This neurectomy lessens pain and diminishes the uncomfortable flow of the saliva. The pain which makes lingual movements distressing may also be mitigated by painting the diseased tissue with cocaine, about forty grains to the ounce. The patient may require feeding by enemas, or by having a tube passed through the nostril into the pharynx. Œsophagotomy may be available for feeding in cases where the fauces are obstructed by the growth.

It has been proposed to perform tracheotomy in order to prevent inhalation of the foul discharges which give rise to septic pneumonia. This seems scarcely necessary, since the free use of antiseptics with frequent powdering of the cancer with iodoform will preserve a fairly clean condition of the ulcer.

The tongue can be entirely removed by dragging it forward while the mouth is held open by a gag. A strong string passed through the organ at its tip will give the operator control of it, and enable him to pull it well out of the mouth, and by successive manipulations with the scissors the organ can be cut away without difficulty, and the spurting vessels tied as they are divided. It is well to have a ligature of silk passed through the stump and brought out of the mouth after the removal of the organ, in order that the patient may not be suffocated by the base of the tongue falling backward into the pharynx. This danger does not exist after twenty-four hours have elapsed.

It is often advantageous to split the tongue in the middle line antero-posteriorly before attempting its complete removal with the scissors. So, also, in cases where the écraseur is applied to extirpate the organ, it is well to operate upon the two halves successively. Operation with the scissors, however, seems more surgical and accurate than that by means of the écraseur, because the direction and extent of the incision can be better regulated. The mouth should be well packed, after drying of the stump, with iodoform gauze, which should be pushed into every irregularity of the mouth, and retained several days until cicatrization of all the surfaces has been accomplished. The patient should not be allowed to talk or take food by the mouth for a week. Alimentation can be kept up by the rectum.

If this radical operation is done early in the course of the disease, a considerable prolongation of life is usually secured. It is, however, bad surgery to attempt partial removal of the organ in cases of malignant disease.

Access to the tongue, in order to accomplish its complete removal, may be obtained by making a horseshoe incision in the throat under the lower jaw, going through the floor of the mouth, or by making a straight cut from the centre of the lip to the chin, accompanied by division of the jaw bone with a saw at the symphysis. Ordinarily, however, the method first described—namely, that of dragging the tongue out of the mouth—is efficacious.

Subsequent to the removal of the tongue, the speech is not so imperfect as would be expected.

Diseases of the Tonsils.

Tonsillitis, or quinsy, may go on to suppuration, and require incision for the evacuation of pus. A sharp-pointed bistoury should be carried through the swollen gland and the surrounding tissue until the pus collection is entered. Usually the abscess is localized at the upper point of the tonsil, where it joins the soft palate. The point of the knife must never be carried outward, since the internal carotid artery lies just external to the gland. Detergent washes should be used after the operation. Relief is immediate. A solution of sodium bicarbonate has been highly lauded as an application in quinsy prior to the stage of suppuration. Syphilitic lesions and malignant tumors are at times found in the tonsil glands.

Hypertrophy of the tonsils is a chronic condition, probably inflammatory in its character, which is often seen in children. These enlarged tonsils are frequently associated with recurrent attacks of inflammation of the throat, and it is possible that they may have some relation to local tubercular infection. The increase in size may be so great that the enlarged glands extend to or beyond the middle line of the fauces, so that the opposite growths come in contact and result in mutual pressure. Ulceration of the masses may be thus induced. The disease causes obstruction to breathing and swallowing, and compels the child to keep its mouth open almost constantly, and to snore during sleep. When the enlarged glands are attacked with acute inflammation, the difficulty in breathing may approach suffocation.

Fig. 365.

Tonsillotome.

The medical treatment of enlarged tonsils consists in the use of astringent gargles, the application of nitrate of silver, improved hygienic surroundings, and the internal administration of good food, cod-liver oil, iodide of iron, and other tonics. Surgical treatment is often demanded because of the inefficiency of these measures. It consists in excision of a portion of the enlarged gland by means of a guillotine or tonsillotome. The operation is not a dangerous or painful one, and may be done to very young children without an anæsthetic. A solution of cocaine may be painted upon the surface of the enlarged tonsils, if the child is very sensitive. Only that portion of the growth which projects into the ring of the tonsillotome, when it is laid over the organ, should be removed. Even when only a comparatively small portion is cut away the operation is successful, since atrophy of the hypertrophied mass is very apt to occur afterward. The hemorrhage is only very slight usually, although cases have been reported in which it has been profuse. In such cases it is proper to seize the bleeding point with a hemostatic forceps, which should be left in position for a few hours. Detergent gargles should be used after the operation.

When the circular knife, to which the name guillotine or tonsillotome is applied, is not at hand, the hypertrophic tissue may be cut away with a probe-pointed bistoury, after the apex of the mass has been seized with

a pair of toothed forceps. This method is less rapid, and more apt to frighten the child, than the other.

Salivary Fistule.

Fistules of the salivary ducts may be upon the inside or upon the outside of the mouth. If the abnormal opening is in the oral cavity itself, it requires no treatment. If, however, the opening is so placed that the saliva escapes upon the external surface of the face, it is necessary to operate in order to turn the current into the mouth. Salivary fistules are due to wounds, to abscesses, to calculi impacted in the ducts, or to obstruction from inflammation of the ducts. The amount of saliva that escapes from a salivary fistule during mastication may be as much as a drachm within a few minutes. The fluid can be recognized as salivary by the characteristic test with potassium sulpho-cyanide and with ferric chloride. I once saw a case of inflammation of the parotid gland in which a transudate appeared upon the surface of the cheek which seemed to be saliva. This local escape of fluid in drops like sweat was lessened by passing a probe into the duct from the mouth, and relieving the obstruction. Unfortunately, the patient passed out of my hands before I was able to make a test to prove that the fluid upon the cheek was really saliva.

The treatment of salivary fistule must begin with removal of the calculi or other causative influence. A new opening must then be made from the mouth into the duct behind the site of the external opening. This can be done by inserting a probe into the external orifice, passing it along the duct upward toward the gland and making its point push up the mucous membrane in the mouth. An incision can then be made upon the point of the probe and a comparatively large opening made from the duct into the mouth so that the saliva will flow into the buccal cavity. This new orifice must be kept open by means of daily insertions of a probe from within the mouth. When the internal opening has been permanently established the external fistule will soon heal; if not, this may be accomplished by the application of caustics, or the orifice can be closed by a plastic operation.

Retro-pharyngeal Abscess.

Retro-pharyngeal abscess is a collection of pus between the posterior wall of the pharynx and the anterior surface of the vertebral bodies in the cervical region. It is not unusual in adults, but occurs especially in children of unhealthy constitution. It may result from caries of the cervical vertebræ, from suppuration of the lymphatic glands behind the pharynx, or from suppuration in some neighboring region burrowing behind the constrictor muscles of the pharynx. At other times, however, its cause is not apparent. Acute abscess is necessarily more dangerous and more rapid in its course than a chronic tuberculous collection of puriform matter in this locality. The difficulty in breathing and swallowing associated with a soft, fluctuating swelling at the back of the pharynx makes the diagnosis evident. The abscess is not always in the middle line and may give rise to some stiffness of the neck due to an attempt on the part of the muscles to fix the vertebral articulation and prevent pain. In the event of spontaneous evacuation of the abscess

there is danger of the quantity of pus being large enough to suffocate the patient from its entrance into the larynx. At other times the contents of the abscess cavity pass into the stomach or are spat out. In rare cases the pus burrows into the posterior mediastinum or along the muscle sheaths and fascial spaces of the neck. Early and free evacuation of the pus is the essential treatment. It is accomplished by making a vertical incision through the posterior pharyngeal wall with the patient's mouth wide open, and in getting rid of the pus, which is often very large in amount, so as to obviate the possibility of the patient drowning. It may be wise to evacuate the major portion of the pus by means of a trocar and canula in order that the gush of fluid may not asphyxiate the patient by getting into the larynx. Subsequently the cavity must be freely opened with a knife. Astringent and disinfectant washes should thereafter be used.

Diseases of the Œsophagus.

Wounds of the œsophagus, if external, are usually indicated by the escape of food from the opening. Deglutition is accompanied by pain, and emphysema of the cellular tissues of the neck may occur as a secondary symptom.

Rupture of the œsophagus may occur, though rarely, as a result of violent vomiting; and more frequently as a sequence of stricture or malignant disease which has caused softening and thinning of the coats. Feeding with liquids introduced by means of a tube passed through the injured gullet is necessary in these cases if nutrition is not kept up by means of rectal injections. External wounds should be sutured by means of stitches passed through the œsophageal wall, and provision for drainage externally should be made because of the dangers of pus collection in the deep tissues of the neck. Such retained pus might very readily be the cause of mediastinal abscess or pleural inflammation.

Foreign Bodies in the Œsophagus.

Foreign substances swallowed may be caught in the pharynx or œsophagus instead of passing into the stomach. Dental plates and artificial teeth are not infrequently thus swallowed, and food sometimes becomes impacted in the œsophagus, giving rise to trouble. Very rarely fruit stones and substances which have previously entered the stomach have become impacted in the œsophagus during vomiting. Bullets and other missiles may enter the œsophagus through external wounds in the neck and throat. Persons of hysterical temperament sometimes imagine that foreign bodies are lodged in the gullet when no such condition exists.

Sharp pieces of bone may, during their passage through the gullet, scrape the mucous membrane and cause irritation, thus giving the patient the sensation of a foreign substance impacted in the canal after the vulnerating body has actually passed into the stomach.

Symptoms.—A comparatively large foreign body, lodged in the upper end of the œsophagus or in the lower portion of the pharynx, causes a feeling of suffocation, violent paroxysms of dyspnœa on attempting to swallow, repeated and vigorous efforts at deglutition, retching, spitting of saliva, possibly mixed with blood, bulging of the eyes, and great anxiety on the part of the patient, accompanied with sweating and prostration. Pressure on

the larynx by, or a spasmodic condition of the glottis produced by irritation from, a foreign body may cause asphyxia and death. Loss of voice, dysphagia, and pain are also symptoms. The combination of symptoms seen varies with the size and character of the impacted body. Small and sharp foreign substances will give rise perhaps to difficulty of respiration without much actual interference with swallowing, but are apt to be accompanied with blood expectoration. The position of the body also causes change in the combination of symptoms. It is possible in some cases to feel the obstructing substance by thrusting the finger into the back part of the fauces and down the pharynx, or by palpation of the throat externally. Auscultation of the œsophagus by means of the stethoscope, placed upon the exterior of the neck, sometimes gives aid in diagnosis, because fluids or other food swallowed are arrested or diverted in their course by the impacted substance, and therefore produce sounds which can be distinctly heard through the stethoscope.

Inflammation of the œsophagus followed by ulceration, perforation, or abscess, may result from prolonged retention of a foreign body; and cicatricial contraction due to such inflammatory processes may cause stricture of the œsophagus. Secondary to this stricture, dilatation above the point of stricture and contraction of the normal tube below may supervene. Perforation from a sharp foreign body or from abscess may involve the pericardium, the heart, the trachea, the pleura, the mediastinum, or the aorta. Such secondary lesions are more apt to occur and prove fatal when the foreign substance is lodged low down in the œsophagus. The presence of a foreign body in the gullet may often be proved by carefully passing into the œsophagus a bougie or probang, which consists of an olive-shaped tip attached to a long, flexible stem. Such a bougie may push small foreign bodies before it into the stomach, thereby relieving the existing condition. It may, however, pass by a small bone or similar object without dislodging it, and without giving the sensation of having passed an obstruction.

Treatment.—Masses of food and foreign bodies of moderate size may be carefully pushed into the stomach by the œsophageal bougie. This operation should be very carefully attempted lest the œsophagus be ruptured, or the mucous membrane scraped loose. Substances lodged in the upper portion of the gullet may be extracted through the mouth by the finger of the surgeon or by curved forceps. Several forms of instruments to draw out coins and similar substances from the lower part of the œsophagus have been constructed. A very good method is to fasten a dry piece of a sponge on to the end of a rod of whalebone and pass this beyond the obstruction. The sponge, after becoming swollen by the fluids of the œsophagus, fills the calibre of the tube, and on being withdrawn brings up the obstructing substance. A somewhat similar instrument is made of horse-hair, which after its introduction and passage beneath the obstruction is distended until it fills the tube. Its withdrawal carries the offending substances upward into the mouth.

Vomiting may be induced by hypodermic injections of apomorphia (gr. $\frac{1}{12}$ to gr. $\frac{1}{10}$), or by the administration of emetics by the stomach, to cause ejection of the body in the œsophagus. Inversion of the patient's body has sometimes been successful in causing expulsion of the offending substance. There is, however, some danger in this procedure of causing asphyxia from the foreign substance becoming lodged in the upper portion of the œsophagus or at the opening of the glottis. Where the symptoms of dyspnœa are marked, either before the attempt at removal or

during such effort, tracheotomy should be performed as a preliminary precaution.

If the methods described are ineffectual in relieving the patient's condition it then becomes necessary to open the œsophagus. This operation is called œsophagotomy. If the operation is done high up in the throat the name pharyngotomy is applied. As it is only possible to open the food tract in the upper portion of the neck, it is probable that what many operators call œsophagotomy is actually pharyngotomy. External œsophagotomy or pharyngotomy is usually performed on the left side of the neck, because the œsophagus is located a little to the left of the median line. If, however, the body to be extracted is more prominent on the right side, there is no objection to making the incision on that aspect. It is only necessary to describe left-sided œsophagotomy, since that upon the right side is done in a similar manner.

During the operation the head should be turned a little to the right. An incision parallel to the anterior border of the sterno-cleido-mastoid muscle should be made, beginning on a level with the upper border of the thyroid cartilage and extending downward toward the sternum for four or five inches. This incision should be carried through the tissue between the sheath of the carotid artery and the sterno-hyoid and the sterno-thyroid muscles. The thyroid body and trachea should be pushed toward the middle line and the sheath of the carotid vessels drawn outward. In this space will be seen the omo-hyoid muscle which may be drawn aside and divided. Care should be taken to avoid the inferior thyroid artery, and also the recurrent laryngeal nerve. The latter structure lies in the groove between the trachea and the œsophagus. When the gullet has been exposed at the bottom of the wound, it is well, if the foreign body does not make a projection, to pass a bougie with a large tip through the mouth, in order that the gullet wall may be pushed up toward the surface and be made easily accessible for incision. A silk ligature may be passed through the œsophageal tissues by means of a curved needle, in order to give the surgeon control and to enable him to lift the wall toward the external wound. A small incision is next made into the œsophagus and an exploratory finger passed into the opening, which is subsequently enlarged in a longitudinal direction if necessary. The foreign body is then extracted with forceps, the œsophageal wound is closed with sutures, and provision made for drainage of the external wound, the edges of which may be united by buried and superficial sutures.

Tumors of the Œsophagus.

Pathology.—Growths of benign character are quite rare in the œsophagus, but primary malignant disease in this locality is not infrequent. Of the forms of tumor epithelioma is the most common, and it usually attacks the œsophageal tube either at the upper or lower extremity. The affection is one occurring late in life, and more frequently, it would seem, in man than in woman. Involvement of the surrounding glands and tissues is quite common and ulceration of the growth usual. The disease has a rather rapid course toward death, its average duration being from four to sixteen months. The fatal issue occurs from hemorrhage; from starvation, the result of the contraction caused by the growth preventing the administration of food; from asphyxia, due to pressure on

the trachea and the primary bronchi, and from secondary lung conditions.

Symptoms.—The symptoms are like those of non-malignant stricture hereafter to be described, and consist of pain, difficulty in swallowing, regurgitation of food, offensive breath, delayed digestion, constipation, inanition, and great debility. The gullet is apt to be dilated above the site of the epitheliomatous stricture, and may become perforated by ulcers in the neighborhood of the malignant growth. Symptoms arising from pressure upon the neighboring viscera may be prominent, and in some cases there is external evidence of tumor.

Diagnosis.—The early stages of malignant disease of the œsophagus may resemble hysterical stricture. A tumor outside of the œsophagus pressing the wall inward will give similar symptoms, and at times render diagnosis of the true condition difficult. Exploration of the œsophagus with a flexible bougie, such as was described in the discussion of foreign bodies lodged in the œsophagus, will prove the existence of a growth of some sort if the contraction made by it is at all conspicuous. It may be possible to differentiate the histological elements and to characterize the nature of the growth by microscopical examination of the tissue scraped off by the bougie.

Fibroid growths of the œsophagus give the impression of a smooth surface when touched with the bougie, are much more resistant than a malignant tumor, and do not bleed. Hemorrhage occurring after careful manipulation suggests malignant tumor, as does, of course, the existence of a purulent, bloody discharge.

Treatment.—If the disease is situated in the upper portion of the tube, œsophagotomy may permit the removal of the tumor if small, or œsophagostomy, which is the formation of a permanent opening in the œsophagus, will establish an opening by which food can be administered. Removal of such growths by opening the gullet is only justifiable when the disease is limited. In other cases a small bougie may be passed every two or three days in the effort to keep the tube open and to allow the food to be administered by the normal channel. If the operations suggested are not deemed advisable the performance of gastrostomy will permit feeding by fistule so made in the stomach. Gastrostomy is often delayed too long until the patient is too weak to enjoy long the benefit of the operation. In the event of these operative measures being impossible, the surgeon can do nothing but render death easy by palliating measures.

Stricture of the Œsophagus.

Pathology.—Diminution in the calibre of the œsophagus may be due to organic changes and contractions resulting from malignant disease and the other conditions which have been mentioned, and to cicatricial contraction following inflammation of the œsophageal coats. Swallowing hot liquids or strong acids and alkalies with suicidal intent, or by accident, are frequent causes of such coarctations. Syphilis, tuberculosis of the mucous and submucous tissues of the gullet, and wounds due to foreign bodies may, in a similar manner, lead to obstruction in the œsophagus. So, also, aneurism, foreign bodies in the trachea, and abscesses or tumors outside the œsophagus may, by pressure upon its walls, cause diminution of its calibre. The condition called œsophagismus, or spasm of the muscular coat of the œsophagus, which occurs at

times in hysteria, gives rise to symptoms of stricture. A bougie can, however, be readily passed through the contracted portion, and meets in its passage with no perceptible resistance. Indeed, the successful introduction of such a bougie will often convince the patient that no danger from obstruction exists, and be thus the means of curing the symptoms. Auscultation with a stethoscope, placed over the œsophagus on the left side of the neck, is said to give information that the stricture is spasmodic and not an organic one. In the former case food which has been swallowed is regurgitated immediately; but in the case of true stricture regurgitation of ingested materials is more slow. Œsophagismus, moreover, is intermittent and not constant. The medical treatment of this hysterical affection consists in curing the coincident nervous symptoms. Fibroid or cicatricial strictures usually take place in the upper part of the œsophagus or in the pharynx. The contraction may be due to a puckering of the inner coats of the tube at the site of the scar, it may consist in a crescentic ridge extending partly around the tube on its internal surface, or it may be a cicatricial ring involving the entire circumference of the gullet. Abscess about the injured portion may be present.

Symptoms.—Difficulty in swallowing solid food is one of the early symptoms of œsophageal stricture. If the contraction increases, deglutition of liquid foods soon becomes difficult. Regurgitation of food may take place after it has reached this stage, and may be slight, or amount to actual œsophageal vomiting. The time at which regurgitation or vomiting takes place, after the attempt at swallowing food, gives an approximate idea of the position of the disease. The food when ejected may be more or less putrid, and mixed with blood or smeared with mucus. A discharge from the œsophagus, having a coffee-color, is symptomatic of malignant disease. The pain is usually slight at first, unless there is acute inflammation accompanying the stricture; severe pain may then be experienced. It may radiate to the shoulders and to the epigastrium. The location of the most severe and constant pain may indicate the seat of stricture, which may be more or less certainly ascertained by the sense of stoppage in the food-tract when the patient endeavors to swallow nutriment. The use of the stethoscope may give the surgeon an idea of the position of the disease, because he may thereby learn the point at which food stops in swallowing, or the point through which the food passes with difficulty. Palpation of the throat may at times reveal the mass which has caused the obstruction. The lodgement of food which takes place above the contracted portion causes dilatation and hypertrophy of the wall of the gullet. Great debility and emaciation are later symptoms of the disease and are particularly slow in their progress when the stricture is a cicatricial one rather than a malignant one.

The passage of an œsophageal bougie will give the surgeon information as to the distance from the front teeth, and the length, number, and calibre of the contracted portions.

Treatment.—The treatment of œsophageal stricture consists in giving rest to the diseased organ, in nourishing the patient, and in dilating the contracted tube. Rest is obtained by keeping up the patient's nutrition through rectal injections of milk, broth, and other nutritious articles. This procedure is of special value if there is great sensitiveness of the œsophagus, since efforts at alimentation through the œsophagus then cause great distress and depression of the patient.

Dilatation of the contracted and contracting œsophagus is accomplished

by the introduction of bougies with conical tips, the size of which is gradually increased. The bougie should not be passed oftener, as a rule, than once in three days, but at one sitting two or three increasing sizes may be successively introduced, each of which may be left in position about ten minutes. Such intermittent dilatation should be made in a gradual manner, since attempt to pass a large bougie after the passage of a much smaller one, is liable to cause laceration of the tissues. Rapid dilatation is not safe, even if it were possible to substitute it for slow intermittent dilatation, which has just been recommended. Continuous dilatation can be accomplished by the introduction and leaving in position of tubes large enough to stretch the strictured portion slightly. Through this tube, which may be allowed to remain for three or four days, food can be introduced. At the end of this time the tube should be taken out to be cleaned, and should then be reinserted or succeeded by a tube slightly larger.

There are other œsophageal bougies which, after being placed in position through the stricture, may be dilated with air or water. Again, there are dilators which can be spread, after their introduction, in much the same manner as instruments used for dilating strictures of the urethra.

Internal œsophagotomy, or division of the stricture, by a sharp blade concealed in a sheath during its introduction through the mouth and pharynx is dangerous because of the liability of dividing the wall of the gullet as well as the stricture. It is good practice in certain cases to perform external œsophagotomy just above or just below the stricture, and then to make an internal œsophagotomy.

External œsophagotomy, or opening of the œsophageal tube from the exterior of the throat may be useful, as has just been stated, to gain access to the stricture in order that it may be dilated or incised, and also for the purpose of obtaining an opening through which food may be passed into the stomach. In the latter case the operation is called œsophagostomy. Such operations, it is evident, can only be done when the disease is situated high in the neck and gives room for an external incision above the clavicle. When the disease is situated in the lower portion of the gullet the stomach should be opened through the abdominal wall and a gastric fistule established for the introduction of food. This operation is called gastrostomy or "stomach-mouth" in contra-distinction to gastrotomy, in which the stomach is opened for the removal of a foreign body and immediately closed.

Introduction of the Œsophageal Bougie or Stomach-pump Tube.

Tubes or bougies may require to be introduced into the œsophagus alone or into the cavity of the stomach for purposes of diagnosis, for the treatment of stricture, for the evacuation of poisons which may have entered the stomach, for washing out the stomach, and for feeding. It is important, therefore, that the surgeon should be familiar with the method of using these diagnostic and therapeutic instruments. The patient should be seated with his head thrown well back, in order to bring the mouth and the long axis of the gullet in the same line. The mouth, which should be wide open, may or may not be prevented from closing by means of a gag between the teeth. This is seldom needed, except in obstreperous patients. The surgeon, standing in front of the patient, should then pass the instrument, which has previously been well oiled and

warmed, through the mouth backward toward the posterior wall of the pharynx. This portion of the operation should be done without touching the patient's tongue. With his left forefinger the operator next guides the instrument above the epiglottis and downward into the upper portion of the œsophagus. Pressure slowly applied then pushes the instrument downward toward the stomach. If any obstruction is felt the instrument should be slightly withdrawn and again gently pushed forward. The patient will soon discover that he can breathe notwithstanding the presence of a foreign body in the food-tract, and he will suffer little or no inconvenience. Care must be taken, however, not to push the instrument into the trachea, which is likely to occur if the tube be a small one. If the surgeon prefer, he may stand behind the patient and, steadying the latter's head against his chest, introduce the bougie or tube from this position. In this method, however, the surgeon's forefinger cannot be used to insure the slipping of the instrument over the epiglottis. It therefore requires a little more dexterity on the part of the surgeon.

When the tube of the stomach-pump is thus introduced for washing out the stomach, about two pints of warm water should be allowed to flow through the tube. This may be done by pouring water into a funnel attached to the outer end of the tube, or by attaching to this extremity some form of a pump. When the fluid is withdrawn from the stomach it is wise not to permit all to come out, as the mucous membrane lining of the stomach may be sucked into the opening at the gastric extremity of the tube.

CHAPTER XXI.

DISEASES OF THE ABDOMEN AND PELVIS.

THE fœtal canal extending from the bladder to the umbilicus may remain patulous after birth. This tubular canal may then permit the discharge of small quantities of urine at the umbilicus. In rare instances such an unobliterated urachus has been laid open in performing abdominal section for the treatment of abdominal disease. Cystic tumor, abscess, and other pathological processes may occur here. Urinary calculi have been found in a patulous urachus.

Wounds of the abdomen, when fatal, have probably caused injury to the solar plexus, or to some one of the glandular or hollow viscera; which injury will be revealed by an autopsy. Death occurring without discovable lesion is very infrequent. Contusions or wounds of the abdominal wall have no special importance except when associated with rupture of the viscera or some other internal lesion. They are treated, when uncomplicated, as are wounds in other regions. When there is a probability of visceral lesion as a complication, the necessity for abdominal section and exploration is often imperative.

Wounds of the abdomen are of extreme importance, because of the probability of injury to the contents of the abdomen and pelvis. Gunshot or stab wounds of the belly are so liable to be complicated with intestinal lesions that abdominal section is very often required, in order to secure the patient from death by reason of internal hemorrhage or fecal extravasation into the peritoneal cavity. It is often doubtful whether a bullet or a cutting instrument has actually penetrated the intestines, because at times the vulnerating instrument does not travel the entire thickness of the wall, or is deflected by the muscular fascias. The hydrogen test of Senn consists in inflating the intestinal canal with hydrogen gas introduced through the rectum by means of a rubber tube connected with a reservoir or rubber bag filled with gas. The hydrogen distends the intestinal canal, escapes through any perforation that has been made in it, and after filling the peritoneal sac escapes through the external opening. Its presence at this point is detected by holding a lighted taper to the wound when the gas, as it escapes, becomes ignited. Such ignition is a positive evidence of a wound in the intestines. Unfortunately, however, the absence of the escape of hydrogen is not positive proof that no orifice exists in the gut.

If a doubt exists as to the propriety of opening the abdomen for the purpose of discovering and repairing visceral damage, it is usually wise to give the patient the benefit of the doubt and to operate. Carefully done, aseptic abdominal section is almost free from danger, whereas intestinal wounds have a large death-rate from peritonitis. The exploratory incision should be made in the median line, after which the whole length of the intestinal tract should be carefully examined, unless the wound in the wall has shown that the wounding of the stomach or intestine has been impossible.

Method of Operating within the Abdomen and Pelvis.

Before describing the various operative procedures demanded by abdominal and pelvic diseases and injuries, it is necessary to discuss the general method of performing surgical operations in these cavities. Fluids occurring and accumulating in the abdominal cavity as a result of irritation are very liable to septic changes. Therefore, the most absolute asepsis is important, since the large absorbent surface furnished by the peritoneal membrane makes the occurrence of septic processes in this cavity extremely dangerous. Twisted silk is usually preferred for ligatures by abdominal surgeons, while plaited silk or silkworm-gut is ordinarily deemed most satisfactory for suturing purposes. Catgut, however, is available. These and all instruments and sponges should be rendered absolutely sterile. The use of antiseptic solutions within the abdominal cavity is usually deprecated, because of the danger of these chemical solutions even when weak causing undue irritation. Experience has proved that water sterilized by boiling does not possess this disadvantage, and of course is perfectly safe. The frequency with which the external wound has been sutured when instruments and sponges have been left in the abdomen is sufficient reason to demand that all instruments and sponges shall be counted before and after operation.

The abdominal incision, which should usually be made in the median line, should be large enough to permit good work. It is, perhaps, wise to begin with a small incision, varying with the character of the operation to be performed, and to enlarge it as necessity becomes evident. In operations for appendicitis and other conditions about the cæcal region, an incision to the outer side of the right rectus muscle is often preferable to one in the middle line.

Tumors within the abdomen sometimes become adherent to the anterior wall, and the incision will, therefore, reach them before the surgeon enters the abdominal cavity. Such adhesions of the growth may be suspected if there is much bleeding from the muscular incision, or unusual pinkness of the deep muscular fascias and the subperitoneal fat. In all cases, the surgeon should be careful to get within the abdominal cavity before working along the wall from the incision. If he does not be careful in this regard he may separate a large sheet of peritoneum from the inner surface of the muscles, and think that he is detaching an ovarian cyst or other growth adherent to the internal surface of the abdominal wall.

During operation the intestines should be kept out of the way as much as possible by packing flat, warm, aseptic sponges around the field of operation, so as practically to shut it out from the rest of the peritoneal cavity. These sponges should be squeezed out, or substituted by clean ones when they become saturated with blood, serous fluid, or pus. If it is necessary to allow the intestines to escape from the cavity temporarily, they should be wrapped up in a warm, moist, aseptic towel, which will not allow particles of lint to be detached from it.

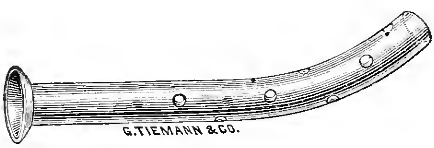
The adhesions and attachments of morbid growths and diseased structures to be removed should be separated by means of the finger, as the tearing thus performed is not very liable to be followed by bleeding. The attachments, if vascular, should be cut only after firm ligation, or compression of the stump by hæmostatic forceps. Points likely to bleed must be ligated before the forceps are removed.

By the toilet of the peritoneum, is meant the removal of all blood and

other fluids by irrigation or by sponges which have been pushed into the pelvic or lumbar fossæ. This may require them to be seized by long forceps, so as to give them a sort of handle. If the fluid is gelatinous or purulent, it will be necessary to wash out the cavity with sterilized water of a temperature of 105°, poured into the cavity from an ordinary pitcher, or from the tube of a fountain syringe. By this means any unrecognized bleeding is discovered, because the water returns stained, and shreds of tissue or lymph are effectively removed. It is not necessary to insist upon the removal of all such sterilized water which has been used to flush the cavity, because it is harmless and is soon absorbed.

Whenever it is believed that a purulent cavity has not been perfectly cleansed, and that purulent material remains, it becomes necessary to leave a drainage-tube in the wound at the time of adjusting the sutures. Healthy peritoneum absorbs aseptic fluids rapidly, but a diseased peritoneum does so very slowly. In such cases, and where there is very great transudation of fluid subsequent to operation, Douglas's pouch becomes the receptacle in which such fluids accumulate; and disastrous inflammation is liable to occur because of the possibility of septic changes occurring there. Hence drainage is often desirable in such cases. If the hemorrhage has not been entirely stopped, or bleeding subsequent to the operation is feared, the insertion of a drainage-tube is wise. Any excess of fluid accumulating after operation may then be removed by introducing a long-nozzle aseptic syringe through the tube at frequent intervals. The occurrence of secondary hemorrhage will be indicated by the escape of blood through the drainage-tube, and will thus be susceptible of prompt treatment. These circumstances render it probable that in cases of doubt as to the necessity of drainage, the surgeon had better use a drainage-tube, since, if the asepsis is perfect, it can scarcely do harm. In cases where the operation has been simple and uncomplicated, however, and when no pus has previously existed, complete closure of the wound without drainage is the proper procedure. A straight or curved glass tube, having a calibre of about a

FIG. 366.



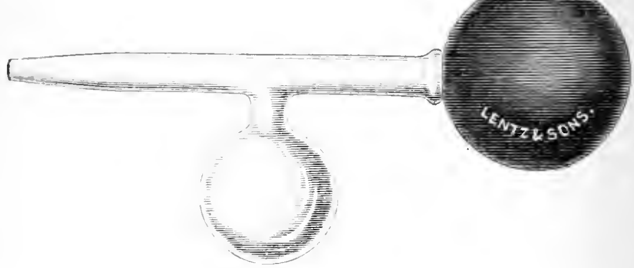
Glass abdominal drainage-tube.

half inch, with an opening in its abdominal extremity, and with a ridge or shoulder at its cutaneous end, is the proper sort of tube to be employed. A piece of rubber tubing will answer the purpose nearly as well. It is rather objectionable to have lateral openings in the tube near its outer end, because fluids entering the tube at its lower end may escape from these lateral openings and becoming septic if the dressings are imperfect, infect the wound in the abdominal wall. The tube, as a rule, should be about six inches long, and descend into the pelvis or one of the lumbar fossæ. Under rare circumstances it becomes necessary to introduce two or three tubes, in order to allow free drainage or irrigation in distinct regions of the abdomen.

Suction with a syringe will remove fluids which accrue in the tube. The escape may be so great as to require this cleansing of the tube every

few hours, or even oftener. The insertion of a small quantity of absorbent cotton, twisted into a rope and put into the tube, will increase the drainage and remove the fluid by capillarity. A sort of wick of absorbent gauze will be efficacious in the same way. It is essential that the abdominal cavity be kept dry and free from fluid when oozing of blood is going on after closure of the wound, because moisture seems to encourage the flow of blood. It goes without saying, of course, that all recognizable bleeding points should be secured by ligatures, or by the application of the cautery, before the abdomen is closed.

FIG. 367.



Tait's syringe.

The abdominal wound should be brought together by sutures of silk, catgut, wormgut, or wire, carried through the entire thickness of the wall, including the peritoneum. Interrupted sutures should be used. If a drainage-tube is to be employed, the suture at the point where the tube comes out should not be tied, so that when, at the end of the second or third day, the tube is removed, the wound may be brought together by this suture and the pain of using a needle avoided. An ordinary gauze dressing, either aseptic or antiseptic, is then applied, and a many-tailed flannel bandage carried around the loins, and secured in such a way as to make equable pressure upon the abdominal wall. If a drainage-tube is used, its external end should be thrust through a small opening made in the centre of a piece of strong rubber tissue about eight inches square. A ligature should then be thrown around the tube in such a way as to tie the rubber material close to the tube. This is to prevent the possibility of fluid escaping from the tube and running down its outside and coming in contact with the wound. By placing a mass of absorbent cotton, or a sponge, over the orifice of the tube, and folding the edges of the rubber dam around it, a little bag is formed in which the escaping fluid is retained, and thus prevented from coming in contact with the wound, which, therefore, heals by first intention. This rubber bag, as it practically is, can be opened several times a day, if necessary, to suck out the tube with a syringe, and to remove the saturated cotton or sponge. This can all be done without disturbing the main dressing.

The after-treatment of cases of abdominal operation is very simple, unless some complication arises. Beef tea, thin arrowroot or oatmeal gruel, given in small quantities about every two hours, is probably the best food. Milk is believed to be improper food, because of its supposed tendency to induce flatulency. As a rule, it is well to give no food for the first twenty-four hours. During this time it is usual to administer only small amounts of water. Most foods are perhaps better digested if pepto-

nized. Thirst is relieved by rather copious injections of water into the rectum, which is better, perhaps, than swallowing large draughts of water by the mouth or sucking ice. Very frequently the catheter will not be demanded; occasionally, however, it is required. Morphia should not be given unless absolutely required, and then in small amounts. It may sometimes be administered hypodermically. It, and all opiates, tend to constipate the patient, to disturb digestion, and to mask symptoms of danger. Vomiting is liable to occur within the first twenty-four hours as a result of the anæsthesia. If it exists, or begins on the third or fourth day, it is probable that it is caused by incipient inflammation of the peritoneum.

The dangers to be feared in abdominal cases are protracted vomiting, tympanites, and peritonitis. The two former are often associated, and are usually indicative of incipient peritonitis. Vomiting is often an effort to get rid of flatus, and is therefore to be looked upon as salutary. Copious vomiting induced by the administration of warm water as an emetic will often aid in the eructation of a large amount of wind, and be of other service. If the distention of the abdomen from flatus is great, it should be relieved by allowing the patient to lie upon his side, or by the introduction of a tube in the rectum. A large rubber catheter, or the tube of a stomach pump makes a good rectal tube for this purpose, and may be left in the rectum for many hours at a time.

Incipient peritonitis, as has been suggested before, is liable to cause vomiting and distention of the abdomen. Relief of the vomiting and of this tympanites will frequently be followed by rapid improvement of the patient. It is probable, therefore, that the early removal of these symptoms prevents the occurrence of destructive peritonitis. The administration of a saline cathartic, such as Epsom salt, Rochelle salt, or Seidlitz powder, so as to produce free evacuation of the bowels, will often give this desirable result. The administration of opium in such cases of operative peritonitis is decidedly harmful and should not be adopted. Turpentine injected into the rectum, about half an ounce of turpentine to the quart of soap-suds, will be of service in similar manner by promoting the discharge of gas and the evacuation of the intestinal contents.

The purgative treatment of incipient peritonitis probably owes its value to the prevention of distention and to the draining of the abdominal organs of their serum. Carminatives, such as ether and peppermint, can be administered by the stomach as adjuvants, but will not very often be required. When vomiting is marked, nutrition should be kept up by rectal feeding, which is best done by the use of peptonized foods in a diluted state.

Traumatic Peritonitis.

Peritonitis, occurring after operations done in the manner just described is rare. If the early symptoms of peritonitis are met by the administration of saline purgatives and if abstinence from the use of opium is enforced, it is probable that active peritoneal inflammation will not often occur. Should it take place it demands active treatment, such as opening of the abdomen in order to wash out and drain from the pelvis the accumulated fluid which has become septic. The continued use of salines in laxative doses and the avoidance of tympany are the essentials in the medical management of this disease. Traumatic peritonitis commonly follows wounds which have not been at once submitted to aseptic or antiseptic treatment. The vulnerating instrument is often a dirty one, and

the clothing of the patient and his surroundings may cause septic inflammation before he reaches the surgeon's hands.

A circumscribed peritonitis occurs, however, in some cases both in operative and accidental wounds. If there is absence of septic infection the lymph exuded seals the wound and healing rapidly occurs. By such an exudation of lymph even a septic peritonitis is sometimes circumscribed and then may not do much harm, because the septic focus has been shut off from the rest of the abdomen by the plastic exudate. It is the diffused septic inflammation of the peritoneum, which gives rise to a large quantity of turbid serum or pus within the peritoneal cavity, which is so fatal.

The symptoms of traumatic peritonitis are vomiting and flatulency with more or less pain and rapid breathing. It must be recollected that pain may be almost absent, however, and that high temperature is often not present. The cause of the peritonitis should always be sought for, and this search will usually demand opening of the abdomen. Intussusception of the intestines, rupture or inflammation about the vermiform appendix, or the pouring out of pus into the pelvic cavity from a ruptured, suppurating Fallopian tube, will often be found to be causes of what was supposed to be traumatic peritonitis following a slight injury. Pus in the abdomen, from whatever cause, demands incision of the abdominal wall and free drainage.

The treatment of traumatic peritonitis will be better understood when the methods of dealing with visceral lesions have been discussed. Tubercular peritonitis and distention of the abdominal cavity with large quantities of serous fluid have been treated effectually by abdominal section, evacuation of the peritoneal fluid, and drainage.

Tapping the Abdomen.

Withdrawing fluid from the peritoneal cavity with a trocar and canula or with an aspirating needle is called paracentesis abdominis.

An incision through the abdominal wall for the purpose of exploring the abdominal contents, or to gain access to the organs in order to perform operations upon them, is called abdominal section or laparotomy.

Paracentesis of the abdomen is seldom employed at the present time, except for the evacuation of serous fluid in the peritoneal cavity, due to cirrhosis of the liver or to disease of the heart or kidneys. Unless the ascitic fluid which distends the abdomen is known to be due to disease of these organs it is better for the surgeon to make a small incision through the abdominal wall and to introduce his finger. By this means not only is the fluid which is causing the distention evacuated, but certain information as to the cause of the accumulation of the fluid is obtained. One or two fingers introduced through a median incision an inch long, midway between the navel and the pubes, will be able to explore the pelvis and the abdomen almost as high as the liver. It is readily seen that tumors and other obscure conditions can be examined in this way and information obtained which will be a valuable guide to operative procedure, or other methods of treatment to be subsequently adopted.

The old practice of tapping the abdomen whenever it is distended with fluid without reference to the location and cause of the distention is now looked upon with disfavor. Ovarian cysts should not be tapped but

removed by laparotomy. Many other conditions of a similar character which were formerly tapped are now treated by radical means.

Paracentesis, therefore, is reserved for cases in which a diagnosis of ascites from disease of the liver, kidney, or heart of a medical kind has been made. In obscure conditions it is proper to make an exploratory incision, since tapping for the evacuation of the fluid gives no information of a definite kind.

Before tapping the abdomen the bladder should be emptied and the possibility of pregnancy considered. The patient during the operation sits upon the edge of the bed, or is propped up in a semi-recumbent position by means of pillows. A trocar and canula, not more than an eighth or a quarter of an inch in diameter, is then thrust through the belly wall in the middle line about two inches below the umbilicus. The forefinger of the surgeon should be placed about an inch from the point of the trocar as a guard, in order that the instrument may not be thrust too deeply into the abdomen. The instrument should be thrust through the tissues with a quick motion and with a little rotation, which causes less pain than a slow puncture, and insures the entrance of the instrument into the peritoneal cavity. The trocar and canula should, of course, be aseptic. It is wise to percuss previously the point at which the perforation is to be made, in order to see that no portion of the bowel lies against the inner surface of the abdominal wall. Occasionally an adhesion between the intestine and the parietal peritoneum at this point may have occurred, and a resulting injury to the bowel from the point of the instrument will occur, unless by percussion giving a resonant note the surgeon suspect such adhesion and selects a point dull on percussion. The possibility of such an adhesion makes it wise to adopt a different point of puncture if paracentesis is repeated at a subsequent date because of the recurrence of the fluid.

A broad, four-tailed bandage placed around the waist in such a way as to permit the escape of the fluid from the canula may be employed to compress the abdomen as the fluid escapes. If the bandage should be applied before the tapping is performed a hole may be cut in it to expose the skin at the point where the perforation is to be made. The four tails being crossed at the back enables the assistant or surgeon to draw the bandage more and more tightly as the belly collapses. If the canula becomes plugged by a portion of omentum or lymph being washed into it, or lying against its end, an aseptic grooved director pushed in will cause the fluid to flow anew. After the withdrawal of the canula the wound needs no other treatment than the application of a piece of aseptic gauze. If oozing of serum continues from the wound a suture may be employed; this, however, is not often required.

Abdominal and Pelvic Abscesses.

There are many different positions in the abdomen and pelvis in which focuses of suppuration may occur. Abscess within the layers of the abdominal wall is not very unusual. The spaces, or loculi, formed by circumscribed peritonitis causing adhesions between the abdomen and the other viscera, or between the viscera and belly wall, may contain pus.

Diffused peritonitis is not uncommon. This is not strictly an abscess, but it is discussed at this point because its treatment and symptoms are those of abscess. It is strictly a purulent effusion into the peritoneal

cavity; because an abscess is an abnormal cavity containing pus, whereas the peritoneum is a normal cavity. Hence free pus in the peritoneum is a purulent effusion.

Abscesses may exist in the parenchyma of one of the solid viscera, such as the liver and spleen. The Fallopian tube may become distended with pus and give rise to the condition called pyosalpinx.

Again, suppurative processes may occur behind the peritoneum, in the space occupied by the kidneys and other retro-peritoneal organs. Abscess is also possible between the layers of the mesentery; while suppuration around the vermiform appendix and cæcum is quite common.

Parietal abscess presents symptoms similar to abscess in other locations and is to be treated in a similar manner by evacuation of the pus. It derives its importance from the fact that it, and especially cheesy or tubercular deposits, or the accumulation of cheesy pus in this region, may simulate an abdominal tumor. I recently operated upon a case in which the caseous mass was so hard and irregular in outline that I was quite sure that I had a tumor within the belly to deal with until an incision revealed the true character of the condition.

Localized suppurative peritonitis, with the adherent viscera, may resemble tumor within the abdomen. The proper treatment is laparotomy, with evacuation of the purulent collection and the insertion of drainage-tubes. The escape of pus into the peritoneal cavity should if possible be prevented during the operation. Thorough irrigation of the general peritoneal cavity is demanded if any pus accidentally flows into it. Thorough drainage is essential in all cases of visceral abscesses, whether of liver, spleen, or ovary. Abscess behind the peritoneum, or within the layers of the mesentery, should be subjected to the same operative treatment.

Pus in the Fallopian tubes should be treated by removal of the tubes without rupture of them during the operation, since in this manner contact of pus with the peritoneal surfaces is obviated. If the tube becomes ruptured during its forcible separation from the adjacent structures to which it has become adherent, the pelvis and abdomen should be well irrigated and a drainage-tube left in the wound.

Abscess of the vermiform appendix and cæcum should be treated in the same way as pelvic abscess associated with Fallopian suppuration. Removal of the appendix and thorough drainage of the pus cavity are indicated.

Diseases and Injuries of the Stomach.

Physical exploration of the stomach is accomplished by inspection, palpation, percussion, and auscultation of the epigastric region. The contents of the stomach removed by a stomach-tube will, at times, afford valuable information as to the condition of disease. The stomach is usually distended in obstruction of the pylorus, while depression of the epigastric region occurs when the ingress of food is prevented by obstruction at the cardiac orifice. The movements of the stomach may be seen at times when it is dilated. Abnormal growths may often be seen and felt, while these and other conditions often give rise to local pain or tenderness on pressure.

Tumors of the wall of the stomach are examined with difficulty, especially if situated on the left side of the organ. There is a tendency for gastric tumors to be displaced downward by gravity; hence they are seen and felt at a lower level than would be thought possible if this fact were

not remembered. Percussion of the stomach gives a tympanitic note. This may, however, be identical with the note elicited by percussion over the colon. A diagnosis may at times be made by causing the patient to drink a little water, when the stomach loses its tympanitic note, which, however, the colon retains. The lower border of the stomach is situated about midway between the sternum and the umbilicus.

Some information of the gastric condition is obtainable by stethoscopic examination, by which various splashy and gurgling sounds are heard during swallowing and digestion.

Foreign Bodies in the Stomach.

Coins, artificial teeth, and other indigestible substances are liable to be swallowed and become lodged in the stomach or bowels. It is not wise to give a purgative in such cases, but it is proper to delay the passage of the foreign body through the digestive tract by feeding the patient on a diet which is bulky and which will surround the foreign body with a mass of fecal matter. An exclusive diet of potatoes has been recommended with this object in view. If the foreign body is too large to pass with safety through the intestine it is necessary to remove it by operation, provided there is certain evidence by palpation or by the history that the foreign body is actually lodged in the stomach or intestines. Opening the stomach after laparotomy is called gastrotomy, and is to be distinguished from gastrostomy, in which a permanent orifice is made. These operations will be discussed hereafter. Opening the intestine is called enterotomy.

Wounds of the Stomach.

Rupture of the stomach, incised or gunshot wounds of the stomach, and perforating ulcer of the stomach present symptoms similar to the same lesions of the intestines, with the addition of hæmatemesis or vomiting of blood. The treatment is practically the same as that for the corresponding lesions of the intestines, namely: abdominal section with suturing of the gastric wall (gastrorrhaphy). Before such operations are undertaken it is usually wise to wash out the stomach with sterilized water by means of a stomach-tube. If a portion of the stomach has been injured sufficiently to lead probably to local gangrene, it is often best treated by pushing the injured portion toward the interior of the stomach and drawing the neighboring healthy tissue over it by sutures. This is done in order to prevent extravasation of the gastric contents into the peritoneal cavity when the sloughing occurs. Lembert's suture, which will be described under Intestinal Wounds, effectually accomplishes this object, and is the proper method of suturing to be used in closing wounds or a rupture of the gastric wall.

Operations upon the Stomach.

It becomes necessary to define the various terms used to describe operations upon the stomach.

Gastrostomy is the formation of a permanent opening from the exterior of the epigastrium into the stomach, by means of which food may be

introduced. It is performed in cases of œsophageal stricture and of malignant disease of the cardiac orifice of the stomach.

Gastrotomy is an incision into the stomach; and is performed for the removal of foreign bodies, for the purpose of dilating a strictured condition of the pyloric or cardiac orifices, and for the removal of tumor involving the walls of the organ.

Gastrorrhaphy is suturing of the stomach wall, and is demanded in wounds or rupture of the stomach, and in the treatment of perforating ulcers of the stomach.

Pylorectomy is a term used to express excision of the pyloric end of the stomach for malignant disease, just as gastrectomy is applied to operations for the removal of any portion of the stomach.

Gastro-enterostomy is the operation in which an opening or fistule is made between the stomach and a neighboring portion of the intestine. It is employed when the contents of the stomach cannot be passed into the duodenum because of the obstruction of the pyloric orifice or of the duodenum.

Gastrostomy.

Gastrostomy, as is seen from its derivation, signifies a mouth in the stomach. It is performed by attaching the stomach to the anterior belly wall, and making a permanent opening by which food can be introduced into the stomach. The operation is performed in order to prolong life in malignant disease of the œsophagus, and to effect what may practically be a cure in cicatricial stricture of the œsophagus due to injury. The object of the operation, of course, is to prevent starvation, which is the only cause of death in cicatricial stricture. The operation is somewhat more readily performed when the stomach is distended. In cases of obstruction in the œsophagus such as demand gastrostomy the stomach is apt to be collapsed; hence, if the patient can swallow a few ounces of water, it is, perhaps, judicious to have him do so before the operation is undertaken. There is not, however, sufficient advantage gained to insist upon repeated attempts at distention of the organ if it gives the patient annoyance or pain.

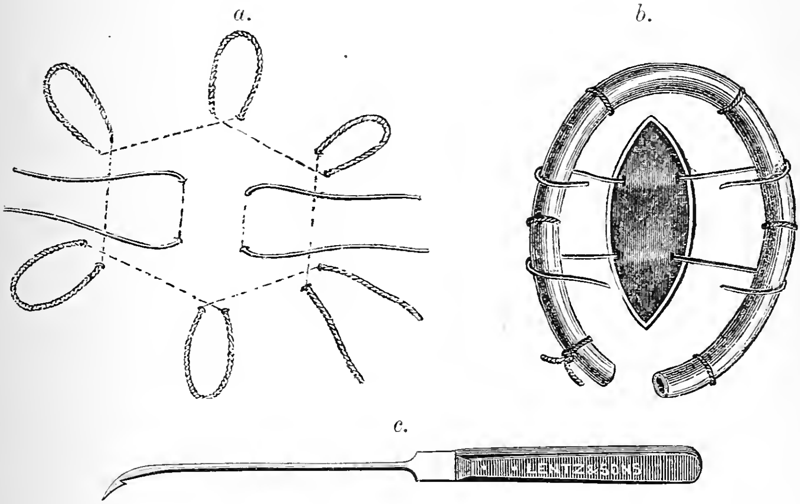
The incision should be made parallel to the costal border of the lower ribs on the left side, and should be about an inch from that border, and from an inch and a half to two inches long. The fistula which is to be made to serve as an artificial mouth should be in the angle between the lower lobe of the liver and the costal cartilages, about one inch from the ribs and one inch from the lower border of the liver.

When the incision through the abdominal muscles has been made, the stomach should be carefully distinguished from the colon, and that part of it selected for the orifice which can be attached readily and well without making traction upon the sutures. It is always wise to allow the stomach to become adherent to the belly wall before the former is opened; hence, the gastric wound should not be made until four or five days have elapsed after the stomach has been sutured to the abdominal parietes. This precaution prevents extravasation of the contents of the stomach into the peritoneal cavity, and should be insisted upon, except in those rare cases where the condition of the patient from starvation is so grave that immediate opening of the stomach for the introduction of food is demanded.

After the abdominal wound has been made and the stomach recognized,

two harelip pins should be thrust through the integument and outer tissues at the edges of the wound and then through the peritoneal and muscular coats of the stomach, so as to fasten that organ against the peritoneum covering the inner surface of the abdominal parietes. These pins should be passed transversely to the line of the external abdominal wound. As a rule, these two pins will be all that is required to hold the stomach in contact with the abdominal surface. If, however, the condition of the patient is such that incision of the stomach may be demanded within a day or two, a few additional sutures of silk may be employed. When immediate opening of the stomach is required, a more complicated system of suturing is necessary, but, if possible, it is wiser to allow four or five days, at least, to elapse before the perforation of the stomach itself, since even this short time will permit a valuable degree of adhesion to occur between the gastric and abdominal surfaces.

FIG. 368.



When immediate operation upon the stomach is to be done, the harelip pins are not used. Two silver-wire sutures are passed through the peritoneal and muscular coats of the stomach by means of a round-pointed needle, which is preferable for most forms of abdominal work to the bayonet-pointed needle. These loops of silver wire, which are transverse to the external abdominal wound, serve to draw up the stomach into contact with the inner margins of the abdominal incision, and to give the surgeon control of the organ. A long silk suture is then passed through the two outer coats of the stomach in the manner shown in the diagram, so that the ends of the loops project upon the exterior of the organ.

By means of a needle fixed in a handle, and with a hook near its point instead of an eye, the abdominal wall is perforated opposite these loops, and each loop by means of the needle is drawn through until it reaches the exterior abdomen a little beyond the wound. A piece of rubber drainage-tube is carried around the external opening of the abdomen, and slipped through the loops made by the silk sutures. By drawing the silk loops tightly down upon the tube and tying the ends over the tube, elastic pressure is made around the whole circumference of the wound. Thus

the gastric and internal abdominal surfaces are held closely in contact, so that no leakage from the stomach, which is about to be opened, can take place into the general peritoneal cavity.

The wire suture which has been used to draw up the organ during these manipulations, can be slipped under the tube and bent over its upper surface, to make the fixation more perfect.

It is to be remembered that in passing the sutures through the stomach wall the mucous coat is not to be perforated. This is in accordance with the method of introducing sutures in operations on the intestines. If the stomach is not to be opened for several days, ordinary antiseptic gauze is placed over the wound until the surgeon is ready to make the gastric orifice.

When the time arrives for the performance of the gastric incision, whether it is to be done as a part of the original operation or as a secondary step, a very small orifice is made through the wall of the stomach by puncturing it with a knife or scissors. A rubber catheter is then slipped into the interior of the organ. The orifice should be very small, and no food should be introduced for some time; then small quantities of liquid food at a temperature of 100°, given every four hours, is proper. Peptonized milk, beef-tea, and similar nourishment should be used. After the first few days, six or eight ounces at a time may be allowed to flow slowly into the stomach.

The catheter is held in place by threads passing through it, or tied around it and fastened to the abdominal skin by adhesive strips. Subsequently the orifice may be enlarged. After a time, solid food may be allowed. It may be masticated by the patient before being put into the tube which leads to the stomach. This method of feeding is only adapted to cases in which the gastric opening has been dilated and increased after the patient has recovered from the original operation.

An absorbent pad is kept over the opening in the intervals of feeding.

Gastrotomy.

This word was formerly used to denote what is now more properly called abdominal section, or laparotomy.

It is used here to signify incision into the stomach which is subsequently to be closed, and differs, therefore, from gastrostomy, in which the opening made into the stomach is permanently maintained. Gastrotomy is performed for the removal of foreign bodies that are of such shape that they cannot pass through the intestinal tract; for the purpose of dilating the cardiac orifices which have become contracted by reason of malignant growths or cicatrices of wounds or ulcers; and also for the removal or curetting of malignant tumors involving the inner surface of the stomach.

The operation is, perhaps, best done after the stomach has been washed out with a weak solution of bicarbonate of sodium (five grains to the ounce), introduced through the mouth by means of a stomach-tube. If this fluid escapes into the abdomen during the operation it can readily be sponged up, and is not liable to irritate the peritoneum.

The external incision should be about two or three inches long, and is made parallel to the costal cartilages on the left side, or over the prominence made by the foreign body in the stomach, if there be any external evidence of it. The fingers of the surgeon are then carefully introduced into the abdomen to feel for the stomach. The area of operation is sur-

rounded with aseptic sponges, and two sutures are introduced into the stomach wall so as to draw it up. These sutures should be parallel to the proposed gastric incision, which, of course, should be in the same direction as the external wound. A round needle passed so as not to perforate the mucous coat, should be used here as in the operation for gastrostomy. An incision is then made into the cavity of the stomach, subsequently the foreign body is removed by the fingers or forceps, dilatation of the pylorus or of the cardiac orifice effected, or other operation contemplated performed. The gastric wound is then closed with twisted silk sutures after the manner of Lembert. A sponge attached to a ligature should be pushed inside the stomach, so as to draw up the edges of the gastric wound. None of the sutures should be tied until all have been properly placed, when the sponge is withdrawn and the sutures tied securely. A second row of sutures may be placed between the Lembert sutures. These should be introduced through the peritoneum only, and taken as ordinary interrupted sutures.

The patient must be supported for three or four days by nutrient enemas.

Suturing gastric wounds, whether accidental or operative, is called gastrorrhaphy.

Tumors of the Stomach.

The tumors found involving the stomach walls are usually, though not necessarily, malignant.

Malignant conditions of the stomach occur usually at the pyloric or cardiac orifices, but other portions of the stomach may be the seat of such conditions. The diagnosis of gastric tumors belongs to medicine rather than to surgery.

The existence of a tumor may be discovered by palpation of the abdomen; but its relation to the stomach must be determined by the digestive and other symptoms accompanying it.

Malignant disease involving the pylorus, or diseases of a similar nature occurring primarily in organs adjacent to the pyloric portion of the stomach, give rise in many instances to stricture of the pylorus. When the growth does not actually involve the pylorus it may lessen its calibre by external compression. Non-malignant stricture of this orifice may also occur. It is stated that there is more anorexia in malignant than in non-malignant stricture of the pylorus. Disappearance of hydrochloric acid from the gastric juice is believed by some writers to occur in gastric carcinoma.

Excision of the pylorus, or pylorectomy, is at times undertaken for the removal of the pylorus for malignant disease.

The term partial gastrectomy is employed to denote this, or, indeed, any operation which removes a portion of the stomach.

Before excision of the pylorus is attempted the stomach should be washed out with a solution of boro-glyceride, or with some other non-poisonous antiseptic, so that the stomach may be empty as well as aseptic. The incision should correspond with the long axis of the stomach and should be about two inches long. The pyloric end is then to be separated from the surrounding structures by means of the finger. It is possible that some adhesions may require to be cut by the scissors, after ligatures have been applied to prevent hemorrhage. The diseased portions of the stomach and of the neighboring duodenum are then removed with the scissors, and the remaining portion of the stomach sutured to the duode-

num in much the same manner as is done after excision or resection of the intestines. On account of the stomach at the point of excision having greater calibre than the duodenum, it becomes necessary to diminish the lumen of the former in order that it may join the duodenum without causing leakage. This may be done by cutting out a V-shaped portion of the muscular and peritoneal coats of the stomach, which narrows its orifice.

In pyloric disease it will sometimes be better for the surgeon to make a permanent opening between the stomach above the pylorus and the intestine below the duodenum by Senn's method of intestinal anastomosis (gastro-enterostomy).

Stricture of Gastric Orifices.

A strictured condition of the pyloric or cardiac orifices may be due to malignant disease, to cicatricial contraction after ulceration in these regions, and perhaps to simple fibrous hypertrophy, similar to that causing fibrous stricture of the rectum. In these cases the symptoms may be ameliorated or cured by opening the stomach, as in gastrotomy, and stretching the contracted opening by means of the fingers or some form of dilating instrument.

The incision should be in the median line of the abdomen. In pyloric stricture the stomach should be opened about an inch from the pylorus and about midway between the greater and lesser curvatures. After one finger has been inserted through the contracted pylorus a second finger may be introduced and sufficient stretching applied to bring the fingers an inch and a half to two inches apart. The distance, of course, depends upon the character of the contraction and the peculiarities of the individual case.

In operating upon a contracted cardiac opening the gastric incision should be near the cardiac end of the organ. If there is difficulty in reaching the cardiac orifice with the fingers, a pair of dilating forceps, similar to those used for dilating the rectum, may be employed.

In malignant strictures dilatation may add greatly to the patient's comfort and is far less dangerous than gastrectomy.

Diseases and Injuries of the Intestines.

Foreign Bodies.

Foreign bodies in the intestines may require the operation of enterotomy, or incision into the bowel, for their removal. The abdominal opening should be made in the median line, and the bowel opened opposite its mesenteric attachments. After the removal of the foreign body the intestinal wound is closed by Lembert sutures.

Rupture, Wounds, and Perforating Ulcers of the Intestines.

Rupture of the intestines occurs from blows, and is particularly liable to take place when the gut is greatly distended with gas at the time of injury. The symptoms are collapse in varying degree, according to the extent of the injury, burning pain, feeble and irregular pulse, and vomiting. After the contents of the stomach have been ejected, blood and

bile may be vomited. Tympany usually but not necessarily occurs later, after which more marked symptoms of traumatic peritonitis supervene, and are followed by death. If the hemorrhage, extravasation of feces, or shock is very great, death may be immediate.

Typhoid fever ulceration, giving rise to perforation of the intestine, causes a similar set of symptoms, but these are developed, of course, during or after the existence of typhoid fever. In "walking" typhoid fever collapse from perforation may be the first serious symptom noticed.

Rupture, and perforating ulcer of the intestines are uniformly fatal. There is but one rational treatment—immediate laparotomy followed by suturing at the point where the solution of continuity has occurred. The chances of saving life are far greater in traumatic rupture than when perforation has occurred in typhoid fever. Small perforations or tears in soft and almost gangrenous gut, made during abdominal operations, may not be amenable to suture because of the friable condition of the intestinal coats. Here life may at times be saved by simply making the intestinal tube straight, and preventing by mild laxatives the accumulation of feces in the diseased gut. Thus strain is removed from the region of the perforation, and fecal extravasation may not occur. A drainage-tube should be placed in the external wound. This sort of surgery may be safer than resection, which is a prolonged operation. It is only admissible perhaps in such perforations.

In all wounds of the abdominal wall which have penetrated into the abdominal cavity there is danger of death occurring from septic peritonitis due to infection from the instrument at the time of the injury, or to extravasation of feces.

Gunshot wounds and stab wounds made with a long knife almost always wound the hollow or solid viscera. It is probably best, therefore, always to open the abdomen for the purpose of rendering aseptic any wound which is not accompanied with visceral injury, and to repair the damage to the intestines or other organs in cases where such dangerous traumatisms have been produced.

Intestinal wounds are dangerous because of the fecal extravasation which occurs always, unless the wound is quite small, and because the warmth of the abdominal cavity encourages bleeding from injured vessels. In all cases of presumable intestinal wound, abdominal section with examination of the entire length of the intestine is the wisest procedure. If done in a perfectly aseptic manner, according to the principles laid down in the paragraph on abdominal surgery, it is accompanied with no very great risk. If no injury to the viscera is found, the peritoneal cavity should be simply washed out with sterilized water, or some very weak antiseptic solution, and immediately closed.

If from the character of the vulnerating instrument it is probable that septic infection has occurred, a corrosive sublimate solution may be used, but not stronger than 1 to 20,000.

The hydrogen test of Senn, already described under Abdominal Wounds, will often give evidence that the intestine has been perforated before the belly wall is incised. Unfortunately, however, an intestinal wound may exist, and the hydrogen gas not show it, because of mucous membrane plugging the wound and preventing the escape of the gas.

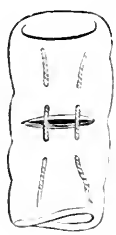
After the abdomen has been opened and intestinal wounds found and sutured, additional wounds will sometimes be discovered with great ease by applying the hydrogen test. Formerly the treatment of abdominal wounds varied a good deal with the occurrence or non-occurrence of pro-

trusion of the viscera. At present very little stress is laid upon protrusion, since in all cases the peritoneal cavity must be rendered aseptic and all complications treated on general aseptic principles.

The cardinal rules are to make the abdominal cavity aseptic, stop hemorrhage, and close the perforated intestine with sutures. All of these procedures demand as a rule immediate laparotomy, which in no instance should be delayed beyond a very few hours. Promptness here is more important than in almost any other field of surgery.

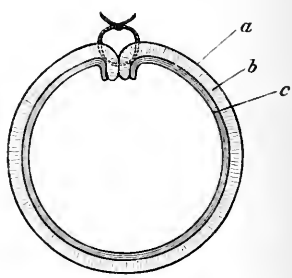
Enterorrhaphy, or suturing of the intestine, is the proper treatment for wounds, whether caused by gunshot or other injury. Lembert's method of placing the sutures is uncomplicated and most effective, and is the one now usually employed. The peritoneal and muscular coats at the two sides of the wound are punctured and drawn together by the suture, while the edges of the wound are turned into the interior of the intestine. By this means rapid occlusion of the wound is obtained because the peritoneal surfaces rapidly adhere by plastic exudation. Round needles are better for this purpose than bayonet-pointed needles, because there is less bleeding from the punctures. The mucous membrane should not be included in the stitch. Either catgut or fine twisted silk may be used. All feces, blood, and serum should be washed out of the abdominal cavity according to the rules adopted for abdominal operations.

Fig. 369.



Lembert's suture. (Ashhurst.)

Fig. 370.



Lembert's suture. *a*, serous, *b* muscular, and *c*, mucous coat. (Smith.)

If the bowel is divided across its calibre the ends must be united by circular suturing, or fastened to the belly wound so as to form an artificial anus. If the bowel or mesentery is so riddled with wounds as to render its preservation improper, resection of intestine (enterectomy) may become necessary. The cut ends may be united by immediate circular suture of the intestine, or if the patient's grave condition contra-indicates this long operation, the two ends of the divided intestine may be attached at the point of incision, so as to form an artificial anus. This may be closed some months afterward, when the patient has recovered from the dangers incident upon the original injury. Such a procedure, although not an ideal operation, will often be the means of saving the patient's life, since there is less danger of fecal extravasation occurring into the peritoneal cavity, and the patient's strength is not exhausted by the prolonged manipulation rendered necessary by circular enterorrhaphy, which would be the case if resected ends were at once sutured. Portions of the intestines which have been subject to contusion or laceration occasionally

slough, and from the perforation so produced extravasation of feces occurs secondarily. Death may occur from such pathological perforation after other portions of the intestines which have been subjected to suturing for wounds have satisfactorily healed. Areas of gut which are very likely to slough had better, therefore, be turned into the lumen of the gut by Lembert sutures passed beyond the slough margins in a manner identical with that which would be necessary if the contained area of tissue were actually a perforating wound.

Small orifices in the bowel, due to gangrenous inflammation, which are at times found during abdominal operations, do not necessarily cause fatal peritonitis by extravasation of feces. If the portion of gut so perforated is placed in a straight position—that is, without curves—there will be little strain in the weakened wall, and often no escape of feces will occur. Fecal extravasation occurring in an abdomen which is left opened so as to permit free drainage and washing is not at all necessarily fatal.

Intestinal Obstruction.

Definition.—By intestinal obstruction is meant such a condition of the intestinal calibre as prevents the passage of fecal matter through it. The term is not applied, however, when the obstruction is due to strangulation of a hernia, although the conditions are practically the same.

Obstruction of the intestine is acute or chronic, although the acute form may assume chronic characteristics and the chronic form may become acute.

Causes.—The bowels may be obstructed by being filled with gall stones, intestinal calculi, or indigestible materials which have been swallowed; by the process of invagination or intussusception, where one portion of the intestine is pushed into the other, as the finger of a glove may be thrust backward into itself; by stricture of the intestinal coats; by adhesions between the intestinal coils; by puckering of the mesentery; by inflammation or malignant disease involving the bowel walls; by twisting and bending of the intestinal tube (volvulus); by bands of inflammatory tissue strangulating the intestine; by pressure from tumors or abscesses; and by the intestines being pushed through congenital or abnormal holes in the mesentery or omentum, or elsewhere, or through orifices made by inflammatory deposits.

Symptoms.—The symptoms of obstruction vary as it is acute or chronic in character. In acute obstruction the pain is commonly marked and is often localized in a particular region of the abdomen, but this locality does not necessarily have to correspond with the seat of the obstruction. Pain from strangulation of the intestine by a band or other similar stricture is usually sudden, intense, localized, and continuous, though it may be somewhat relieved by external pressure. In stricture of the intestines pain is said to be more intermittent in character; while in volvulus it is more diffused than localized. Collapse and actual syncope is marked in many cases of intestinal obstruction, while vomiting, first of the contents of the stomach and subsequently of bile, is usually present. Constipation, tenderness, swelling, and distention of the abdomen are marked symptoms. The rolling of the distended intestines over each other from interference with normal peristaltic action causes at times marked gurgling. If the abdomen is thin the hands placed upon its surface may feel the motion of the intestines, and at times even locate the seat of the ob-

struction. Exhaustion, peritonitis, and gangrene are the usual causes of death. In acute intestinal obstruction death occurs in from one to seven days.

In intussusception the portion of the gut which is pushed into the adjoining part of the intestine may slough off, because of the constriction made upon it by the sheath which grasps it, and be discharged from the anus. The continuity of the calibre of the intestine may be reëstablished in this way, because during the stage preceding sloughing the walls while in contact have become united by inflammatory adhesions.

In chronic obstruction of the bowels pain and vomiting are often not very marked, but obstinate constipation is a prominent sign. Tympanites does not occur early in such cases, but when it occurs it is marked. Spontaneous recovery sometimes takes place, while death, which is a common result, does not occur until after six or eight weeks.

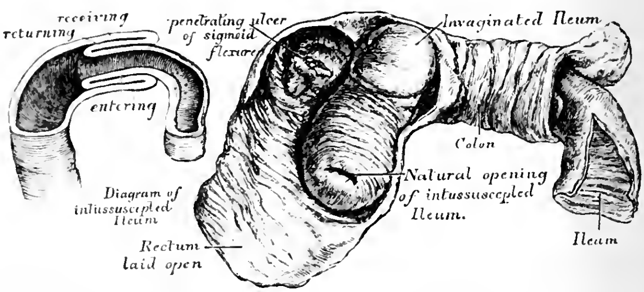
Diagnosis.—In making a diagnosis of intestinal obstruction the possibility of impaction of feces in the rectum, and of strangulated hernia must be excluded. The surgeon should remember also that constipation of an obstinate kind may occur in enteritis and peritonitis, and also in inflammation of an undescended testicle.

It is important to determine the cause of the obstruction and to learn whether the case is of an acute or chronic character. Lead colic may mislead the careless examiner.

A short consideration of the special symptoms of the various forms of intestinal obstruction will here be proper.

Intussusception, or prolapse of one portion of the bowel into the lumen of an adjoining portion, occurs most commonly in children, and is the most frequent form of intestinal obstruction. The invaginated portion, or intususseeptum, usually is above the portion into which it passes, which is called the intussuscipiens, or sheath. Occasionally, however, invagination takes place upward.

Fig. 371.



Intussusception: with a diagram showing the entering, returning, and receiving layers of ileum into colon. (Bryant.)

Polypus of the intestine, worms, or undigested food may be a cause of intussusception. It is believed by some writers that many cases of colic in children are instances of intussusception, which have corrected themselves before inflammatory adhesion of the invaginated coats has taken place.

The sheath, or intussuscipiens, having grasped the invaginated portion, forces it along by peristaltic action, gradually "sucking in" or "swallowing" more of the intestine, just as a mass of feces is pushed along the intestinal canal. Epithelioma is at times found involving the invaginated

gut. It is a question in these cases whether the disease has occurred after the process of invagination, or whether the malignant mass was the origin of the process of invagination.

The most prominent symptom of intussusception is a constant desire to go to stool. With this is associated a discharge of mucus and blood from the rectum. Fecal vomiting is not so often present as in some other forms of obstruction. A sausage-shaped mass may at times be felt or seen through the abdominal wall. This is more frequently found on the left side of the belly. In children it is not uncommon to feel the invaginated portion by the finger introduced into the rectum. The accumulation of feces, which takes place above the seat of obstruction, is occasionally perceived by palpation. It is apt to be upon the right side of the abdomen, and can be indented or pitted by the fingers pressed upon the exterior. This symptom is almost pathognomonic. Invagination may occur without obstruction to the passage of the feces, unless swelling of the mucous and other coats causes obliteration of the lumen. Otherwise obstinate constipation supervenes. When these symptoms do not occur, a certain amount of patency to the canal is retained.

Internal strangulation by inflammatory bands, or by orifices in the mesentery, or omentum, or by rings caused by fœtal structures which have remained within the abdomen, is often called internal hernia. Its most marked symptom is intense prostration or syncope. It does not often occur in infants or in the aged. It presents, of course, the symptoms which have been described as indicative of obstruction.

Twist of the bowel (volvulus), occurs particularly in old people, and usually at the sigmoid or ileo-cæcal region. Actual knotting of the bowel has been discovered. The prostration, however, is not so extreme as in internal strangulation. The abdomen is often unevenly distended, one side being rather flattened, while the other is remarkably tympanitic. It is the right side which most frequently shows flattening, because the sigmoid portion of the colon is the most frequent seat of trouble. The accumulation of gas in the intestines is rapid and great.

Obstruction from stricture or tumor is usually chronic, and affects the lower bowel more frequently than the upper. A history of gradual constipation can at times be obtained, and thus aid in the differential diagnosis. Acute symptoms, however, may suddenly become engrafted upon such a condition of chronic obstruction, and thus add to the difficulty of accurate diagnosis.

Diagnosis.—Obstruction in the small intestine is more apt to be rapid in course, and accompanied with greater pain, than is the same condition in the large intestine. Early vomiting is more conspicuous in obstruction of the small than of the large intestine. In other words, acute symptoms, except in the case of volvulus, are apt to be associated with obstruction of the small intestine, while chronic symptoms are usually due to obstruction of the colon. Less urine is secreted, it is said, as the stricture is tighter. Some writers, however, believe that the diminution of urine is connected with the position in the intestinal tube at which the obstruction occurs. The nearer the stomach the obstruction takes place, the less, it is stated, is the secretion of urine.

Treatment.—The treatment of obstruction should be prompt, but should never consist in the administration of purgatives. If the diagnosis has been made before inflammation of the peritoneum and distention of the abdomen have taken place, and before the patient has been exhausted by the disease, or his condition made more hazardous by the administration

of purgatives, the possibility of relief is much increased. All cases are exceedingly dangerous, but the danger is often increased by injudicious attempts at purgation. The existence of hernia at any of the usual situations, or the presence of impacted feces in the rectum, must first of all be excluded. When this has been done, and enteritis and peritonitis as a cause of the symptom can be set aside, abdominal section should be performed as an exploratory measure within a few hours after the occurrence of obstruction; provided that attempts to relieve the obstruction by large enemas have failed.

Enemas of warm water or oil should be given by means of a long tube, introduced preferably when the patient is in the knee-elbow position. This position will allow gravity to act, and will aid in the introduction of very large quantities of liquid into the bowel. The hydrostatic pressure may be increased by raising the fountain syringe, or other reservoir, several feet above the patient. This can be done by the surgeon mounting a chair or step-ladder. Such large enemas are of value in softening fecal accumulation, and are capable of altering the abnormal positions or twists in the bowel which are causing the symptoms. Inflation of the intestine with air forced in by means of a long tube, connected with a stomach-pump and introduced into the rectum, has its advantages.

If these means fail, a median incision into the abdominal cavity should be made, and two fingers introduced to explore the peritoneal cavity and determine the cause of the obstruction. A short distance below the umbilicus is usually the most advantageous point for the section, unless palpation gives evidence of a higher point in the median line being preferable. Usually the distended intestine will be discovered forcing its way through the incision. The most dilated portion should be seized and the bowel followed along in the direction of the greatest distention and the greatest congestion. This will usually lead to the point of obstruction. Greig Smith states that this method is more satisfactory and more practicable than attempts to find the most constricted portion, and to follow it to the seat of obstruction.

If a foreign body is found, the gut should be opened and the body removed. If it is a gall-stone it will, perhaps, be possible to split it up into fragments by introducing a needle through the intestinal wall. A volvulus or internal strangulation may be relieved by untwisting the coils of gut or cutting through the constricting bands. A stricture of the gut may be treated by opening the intestine and dilating the stricture by means of the fingers, as has been described in the treatment of strictures of the gastric orifices. If it is impossible to deal with the stricture in this way, the diseased portion may be excised, or the intestine may be opened above the obstruction and stitched to the external abdominal wound so as to form an artificial anus. It may be preferable in some cases to form a communication between the intestine above the seat of the disease and that below it, by means of intestinal anastomosis.

In intussusception the invaginated portion may perhaps be withdrawn from the sheath or intussuscipiens. If this is impossible, the establishment of an artificial anus, the performance of lateral anastomosis, or resection of the bowel will be proper.

This line of treatment is that which should be adopted in cases of acute intestinal obstruction.

In chronic cases the adoption of operative measures is not so vigorously demanded, but the case should be watched. No purgatives should be given and large enemas should be used. The patient should be kept

upon concentrated food given in small quantities. In this manner the strength is retained without the formation of large quantities of fecal matter. After this treatment has been carried on unsuccessfully for about a week, abdominal section, with the performance of such intra-abdominal operations as may be suitable for the condition discovered, is proper.

In patients that have been allowed to suffer until their strength is exhausted and their general condition exceedingly bad, the administration of general anæsthesia may be ill-advised. Greig Smith wisely suggests in such cases that an abdominal incision should be made under local anæsthesia by means of cocaine. A quick exploration of the abdomen should then be made and the bowel opened at any convenient point and stitched to the abdominal wound in order to establish an artificial anus. This rapid operation will cause but little shock, and will relieve the immediate symptoms. Several weeks after, when the patient has attained a better general condition, the artificial anus should be dealt with and more radical measures adopted.

In all cases of intestinal obstruction it is important that the great distention of the intestines which exists should be relieved at the time of the operation for the treatment of the obstruction. This is best done by drawing out of the abdomen a coil of the distended gut, receiving it upon a warm antiseptic towel and making an incision into it through which the gas and fecal matter may be forced out by manipulation of the adjoining coils. The incision, which should not be more than three-fourths of an inch in length, should be transverse to the axis of the bowel and upon the side opposite to the mesentery. After the large quantities of gas and all fecal matter in the vicinity have escaped the intestinal wound is closed by Lembert sutures and the intestine replaced.

Tumors of the Intestines and Omentum.

Tumors of various kinds occur in the intestinal walls. Malignant growths are more frequent than other solid tumors in this site, and are more common in the large than in the small bowel. The omentum may also be the seat of solid growths, as, indeed, may be the mesentery. Hydatid tumors are not very infrequent in the abdominal organs in certain portions of the world.

The symptoms of tumor connected with the bowel or the adjacent tissues are pain, ascites, intestinal obstruction, and subacute peritonitis. The symptoms, however, vary with the character of tumor and its location. The abnormal mass is often detectable by palpation of the abdomen, especially if the examination is made previous to the occurrence of abdominal dropsy due to obstruction of the venous current occasioned by pressure on the portal vein and its branches.

The treatment of such growths consists in laparotomy, followed by drainage or excision in the case of cystic tumors, and by such operations as will effect the radical removal of solid tumors or overcome the conditions induced by them. Resection of the intestine or the establishment of a new route for the intestinal contents by means of intestinal anastomosis or the creation of an artificial anus, will be the proper procedure in selected cases.

Operations on the Intestines.

Opening the small intestine for the removal of a foreign body, or for any other cause, is called enterotomy. Resection of the small intestine is

enterectomy; while suturing of a wound of the small intestine is enterorrhaphy.

Colotomy should, in the strict sense of the term, mean opening the colon, but it is frequently employed to designate the formation of a permanent opening between this intestine and the external air. This should really be called colostomy. Colectomy is the excision or resection of a portion of the colon.

Enterotomy, enterectomy, and enterorrhaphy are often used to designate operations on either the large or small intestine.

Artificial Anus.

An artificial anus is a permanent opening between the intestinal canal and the air, through the abdominal wall, by means of which the feces are extruded. The opening may lead into either the small or the large intestine. When only a small portion of the feces escapes through such an orifice, and the remainder is evacuated at the normal anus, the communication between the external air and the intestinal canal is more accurately called a fecal fistule. Such openings are made intentionally, in order to save life during the performance of some abdominal operation; or they are the result of sloughing of the intestine after it has become adherent by inflammation to the parietes of the abdomen. Sloughing of the knuckle of the gut in strangulated hernia is quite frequently the cause of artificial anus.

The bowel around the seat of the opening is adherent to the parietal peritoneum at the margin of the opening. In accidental cases the orifice or fistule is usually distorted and depressed, while the surrounding skin is the seat of eczematous inflammation. There may be two parallel intestinal tubes with their adjoining walls adherent at the seat of the artificial anus, or there may be but a small opening in the bowel which is attached to the belly wall without any bending of the intestine. In the former case the artificial anus is due to the sloughing away of the bent portion or knuckle of intestine which formerly connected the two tubes, now lying parallel to each other. The upper portion of the gut, that is the portion nearest the stomach, is usually dilated, and from it the feces escape; while the lower portion of the gut is collapsed. This lower portion of the gut may, rarely, be situated at the upper portion of the abdominal opening. By rotation it has become uppermost, and then adhered to the upper part of the belly wall before the sloughing occurred. We employ the term upper in a technical sense to mean the portion of the intestine which is furthest from the rectum.

Usually, there is a spur or partition between the two tubes, which is the remains of the adjoining walls of the normal intestine at the point of flexion. It is this spur which tends to cause extrusion of the entire fecal contents through the abnormal anus. If this is absent the contents of the bowel may continue down the tube and escape in the normal manner, with very little escape occurring through the abdominal orifice; which is then a fecal fistule rather than an artificial anus.

Operation may be demanded to repair such an artificial anus or fecal fistule. It is important that it be undertaken before the lower portion of the gut has become so shrivelled or atrophied as to be quite different in calibre from the upper tube. If the artificial anus has occurred high up in the ileum or jejunum, the chyle escapes from the intestinal tract and

causes the patient to suffer from partial or complete starvation. The condition then demands operative interference because of the difficulty in nourishing the patient, as well as on account of the disagreeable nature of the disease.

FIG. 372.

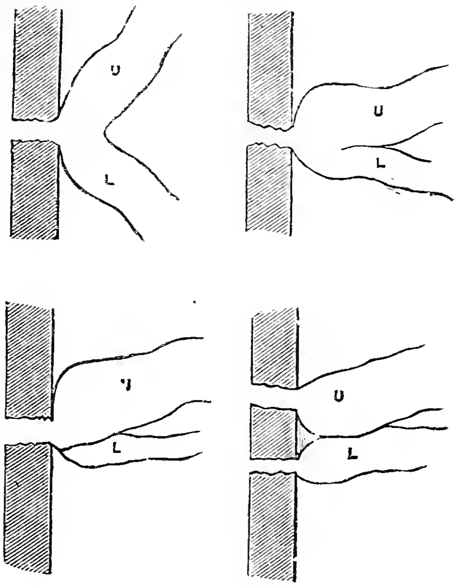


Diagram showing various relations of upper (U) and lower (L) portions of intestine with spur. (GREIG SMITH.)

The introduction of hydrogen gas through the rectum, already described under Wounds of the Abdomen, is a means of proving the relative locality of the opening. If the artificial anus is in the large intestine, the gas will escape from the abnormal orifice very soon after being introduced into the rectum, and there will be no gurgling heard, such as is produced when the gas passes the ileo-cæcal valve. The time elapsing before the gas escapes from the abnormal opening, if it be in the small intestine, will indicate the relative situation of the opening in the small gut.

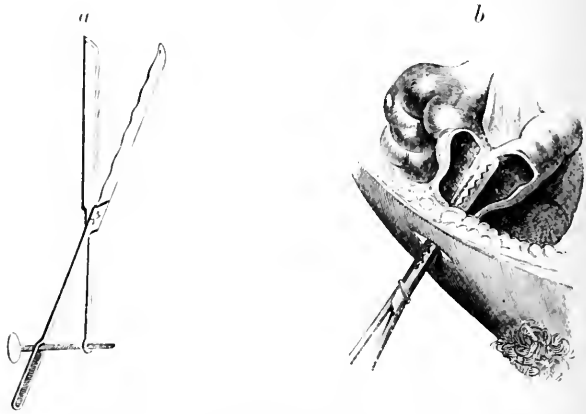
Simple means of closing an artificial opening should be adopted before the more complicated and dangerous procedures are undertaken. When there is no spur, or when only a very small orifice exists, it is possible to cure the condition by the application of the cautery; by paring the edges of the fistule and suturing them together; or by covering the opening by a flap of skin dissected from the surrounding surface after the edges of the opening have been freshened and stitched together.

When a spur directing the fecal matter through the opening exists, it is necessary to remove this partition by pushing it downward, or dividing it, so as to restore the continuity of the intestinal calibre. Mere removal of this obstruction may cause spontaneous closure of the artificial anus. A simple method of depressing the spur is to push into the opening a piece of stiff rubber tubing, which is bent into a sort of horseshoe. The two

ends are thrust into the opening of the tube, and by their tendency to separate the spur is pressed downward. The bent tube can be removed at any time by means of a string which has been attached to it. When the spur is large and thickened it becomes necessary to divide it. This is best done by an enterotome, which, in brief, is a long, two-bladed clamp, by which the spur is grasped and held for several days, until the pressure causes sloughing of the portion of the spur between the jaws. If the clamp cuts too rapidly, there is possibility of a perforation extending into the general peritoneal cavity, particularly if the blades grasp a portion of the intestinal walls at the base of the spur which have not previously been adherent to each other.

The best form of enterotome is that in which the blades have ring-like extremities. This instrument causes sloughing in a circle and, therefore, removes a disk of the spur, instead of making a simple incision through it.

FIG. 373.



a, Enterotome; *b*, enterotome applied. (ASHHURST.)

The opening upon the surface of the abdominal wall is to be closed by a suitable plastic operation, unless spontaneous closure occurs soon after restoration of the line of the bowel by the removal of the obstructive spur.

Resection of the intestine on both sides of the artificial anus, and immediate suturing of the two ends of the gut thus obtained, is a method of treating artificial anus seldom adopted, because of its greater danger than the method just described. It is justifiable, however, in certain cases when milder measures fail.

Appendicitis and Typhlitis.

PATHOLOGY.—Inflammation of the cæcum is called typhlitis; inflammation in and around the cæcum perityphlitis, and inflammation of the vermiform appendix appendicitis.

The terms typhlitis and perityphlitis formerly included all inflammations in this region, but it is now believed that the majority of cases are instances of appendicitis.

Foreign bodies, which may have been swallowed, may become impacted in the vermiform appendix. Small masses of hardened feces, grape seeds,

and small bones are quite often the cause of inflammation of the appendix and the structures in the iliac fossa. It is not unusual for perforation of the appendix to occur subsequently to such impaction and irritation, or, perhaps, from simple ulceration of its coats. Such perforative appendicitis is acute and gives rise to violent general peritonitis. If the condition, however, is a chronic one, adhesions occur about the appendix and shut off the suppurative focus from the general peritoneal cavity. The symptoms thus caused are less rapid, though often fatal.

Repeated attacks of sub-acute inflammation in this region are seen in not a few patients. It is probable that the recurrence is due to pathological changes associated with appendix disease. It is now believed that such disease of the appendix is a source of risk to the patient, and operations are done to remove this worm-like organ during the stage of quiet after a second or third attack of inflammation.

Symptoms.—The differential diagnosis between typhlitis, perityphlitis, and inflammation of the colon above the cæcum is not very easy to make, except in the typical cases where the localization of symptoms and their acuteness indicate the portion of intestine involved.

Sudden perforation of the intestine gives rise to pain and profound collapse, vomiting, tympany, suppurative peritonitis, and death. This may occur to a patient, to all appearances, previously in perfect health. Ordinarily, however, perforation does not occur except after previous inflammatory symptoms.

In chronic cases there is pain, more or less severe in character, in the iliac region, with reflected pain in the groin, hip and front of the thigh. Great tenderness upon pressure in the cæcal region is apt to be present, and, from spasm of the psoas muscle in the effort to avoid pain, the thigh is usually flexed on the pelvis. The bowels may be bound, but sometimes they are actually loose, so that a condition of diarrhœa is present. At other times impaction of the feces occurs, causing a hard mass to be felt in the cæcal region.

The symptoms are those, therefore, of localized peritonitis, with corresponding constitutional phenomena. A hard, doughy mass, the size of a fist, may be found on palpation of the abdominal surface. This induration may also be discovered by rectal exploration with the finger or the inserted hand. Resolution may take place after two or three weeks' illness, or evidences of suppuration may supervene. Rigors, high temperature, especially at night, and other hectic symptoms are not unusual. If the pus burrows under the peritoneum covering the lateral and posterior wall of the abdomen, the symptoms are not so startling as when pus effects an entrance into the general peritoneal cavity. Even in appendicitis the pus may be walled in and prevented from entering the peritoneal cavity by a chronic adhesive inflammation which has been produced about the seat of perforation.

Treatment.—In chronic cases of such inflammation the patient should be put to bed and given saline laxatives, but not active purgatives. Morphia and atropia combined, and in moderate doses, may be given to relieve pain, though the use of these remedies is to be deprecated, as their tendency is to mask symptoms and thus to prevent early operation in appropriate cases. Leeches may be applied locally, or a blister used for counter-irritation. Abundant enemas of warm water, introduced by means of a long rectal tube, are very valuable. Too great pressure, however, should not be employed lest the inflamed and softened intestine be

ruptured. Perforation due to repeated or over-zealous examination of the iliac fossa with the fingers has occurred.

In sub-acute cases the line of treatment just mentioned should be instituted, but preparations for laparotomy should be made so that no delay need occur after the advent of acute symptoms indicating perforation.

In acute perforation immediate laparotomy should be done without waiting for the development of fatal peritonitis.

In chronic cases delay of operation is wise, but if local œdema, rise in temperature, and fluctuation give evidence of the existence of pus, an exploratory operation should be performed.

It often happens that a patient will have inflammation of the iliac fossa, which never again is repeated, but in other instances inflammatory symptoms supervene at irregular intervals without apparent cause, or subsequently to violent exertion, or to indiscretion in diet. As such repeated attacks cause a condition of chronic ill health, it is proper during one of the periods of quiet to open the abdomen and remove the appendix, if it is found to be diseased, as will nearly always be the case.

Chronic pain in this region has been relieved, it is stated, by removing an apparently healthy appendix, which, however, on being opened revealed the existence of ulceration of its mucous surface.

The incision to reach the appendix or cæcum should be from two to four inches long, and a little outside of the right semi-lunar line with its lower extremity about an inch above Poupart's ligament. Every precaution should be taken, by surrounding the field of operation by flat sponges, to keep the pus from the general peritoneal cavity. The appendix will be found at the bottom perforated, gangrenous, or inflamed.

A silk ligature should be tied around its base, after which the appendix should be excised. Its stump may be pushed into the wall of the cæcum in such a manner as to invaginate it, though this is not an essential. If the dimple made by invagination of the stump left after removal of the appendix is a large one, the serous covering of the cæcum may be drawn over the stump by Lembert sutures of catgut.

If general peritonitis exists the peritoneal cavity must be washed out and drainage-tubes inserted. In some cases it will be better not to attempt to complete the operation in this manner, but to be satisfied with thoroughly laying open the part and making provision for thorough disinfection and drainage.

If an opening be found in the cæcum or colon instead of in the appendix, it should be closed by drawing the serous covering over it by Lembert sutures, as in the case of appendix excision.

The operation of removing the appendix during health is simple. The stump should be invaginated and the peritoneum of the cæcum drawn over it.

Colotomy.

When an artificial opening into the colon is established for the purpose of giving exit to the feces, the operation is termed colotomy, though, as previously stated, colostomy would be the more strictly accurate term. A new anus may be made upon either side, and in the lumbar region or in the groin; the former is called lumbar colotomy, the latter inguinal colotomy. The term laparo-colotomy would be better for the last named, since at times the artificial anus is made in the median line between it and the groin. The transverse colon is not often opened, the operation

being usually done upon the sigmoid flexure or cæcum, as would be supposed from the fact that the loin or the inguinal region is usually the place elected for operation.

Colotomy is performed for the relief of imperforate anus, for stricture of the rectum to afford an exit for the feces, and in ulceration of the rectum and recto-vesical fistule in order to put the rectum at rest.

Lumbar colotomy, often called colotomy by Amussat's method, is accomplished by making an incision in the loin. The colon is then opened at the place where it is not covered with peritoneum, but is attached to the posterior abdominal wall by loose cellular tissue. The patient is placed in the prone position with the side to be operated upon elevated by means of a hair pillow placed under the belly. This makes the loin prominent. The anatomical position of the colon is half an inch behind a vertical line drawn upward from the middle of the crest of the ilium. The incision is from two to four inches long and is made midway between the lower rib and the crest of the ilium with its centre over the colon, the position of which has previously been marked on the skin. The incision is made obliquely downward and outward, which makes it nearly parallel to the ribs. The dissection is carried toward the abdomen until the lumbar fascia and the edge of the quadrate muscle is reached. The former is divided and the edge of the latter may be incised if necessary to get room. By tearing through the transversalis muscle and fascia the colon is found in the line previously marked on the skin, a little in front of the border of the quadrate muscle. It is recognized by the feces, which can be felt in it, or by the longitudinal bands of fibrous tissue which characterize the great intestine. If there is not an impassable stricture of the rectum present the intestine may be distended with air by means of an ordinary syringe, the nozzle of which has been passed through a plug fitting the anus. This distention may be a great aid to the recognition of the colon. It is often seen distinctly, however, without such assistance. The nozzle of the syringe may be passed through the centre of a roller bandage made conical. This makes an exceedingly good plug to prevent escape of the air pumped into the rectum by the syringe.

Care must be taken that the peritoneum bulging into the wound be not mistaken for the colon. If the peritoneum should be unwittingly punctured, the edges of this serous membrane should be held together by means of one or two hemostatic forceps, and ligatures of catgut or silk tied around the opening.

The operation is performed on the right side if the obstruction is above the sigmoid flexure. A curved needle should be passed into the wall of the colon and a suture carried through in order to have the ends of the suture for drawing the gut up to the surface of the wound. The colon is then carefully stitched fast to the edges of the wound and opened at once, or after the lapse of two or three days when it has become adherent. The latter method is safer, since the possibility of feces escaping into the tissues around the colon is avoided. The opening may be made without anæsthesia, since the intestinal tissue is not very sensitive. In either event the deep portion of the wound should be carefully sutured and drainage-tubes put in both the upper and lower extremities of the deep wound.

Absorbent dressings to catch the discharging feces should be applied and frequently changed. This is especially necessary if an artificial anus has been made at the time of the original operation. Some prolapse of the mucous membrane often occurs in cases of colotomy, but it does not

usually become very marked. Indeed, an artificial anus often shows a tendency to contract, and dilatation is required to keep it sufficiently patulous.

The patient usually has no great inconvenience from an artificial anus and soon learns to dress it so as to catch any fecal matter which may escape at inconvenient times. Absorbent pads are often more comfortable than any form of plug or receptacle made by instrument-makers. A portion of the feces may in certain cases pass beyond the opening and get into the bowel below. This is due to the fact that when the intestine was brought to the surface it was not sufficiently bent upon itself to make a spur or partition. Various operations have been devised to prevent or remedy this occurrence. In making the artificial anus the surgeon should endeavor to secure a good spur between the upper and lower portions of the tube.

Laparo-colotomy.

When an artificial anus is established in the inguinal region (often called Littré's method), and when the incision and the abdominal opening is made in the middle line, the operation is called laparo-colotomy. This operation has some advantages over lumbar colotomy. The bowel is more easily found, and a more accurate exploration of the condition for which the operation was done is possible. These advantages are particularly marked if the median instead of the inguinal incision is made. If it is found that an opening in the descending portion of the colon would not be serviceable in relieving the obstruction, it is possible to make at once an opening in the ascending colon. This has distinct advantages over the lumbar incision, in which, of course, the large bowel can only be opened upon the side corresponding with the external wound. The anterior operation, moreover, is less serious and troublesome in its performance than the lumbar method, and puts the artificial anus at a place where it can be easily attended to by the patient.

Laparo-colotomy, if done in the inguinal region, requires a two-inch incision, which should be parallel to Poupart's ligament, beginning an inch inside of the anterior-superior spinous process of the ilium. It should be situated a short distance above Poupart's ligament. After the parietal peritoneum has been sutured to the skin the sigmoid flexure is drawn through the opening, and a piece with a rather long mesentery selected. Two silk sutures are then carried through the mesentery close to the bowel, but on opposite sides, and their ends brought out through the skin by means of a needle. These ligatures or sutures should be about three inches apart. The lower ligature is attached to the skin nearer the end of the incision than is the upper one. These ligatures when tied hold the bowel against the inner aspect of the abdominal wound. The protruding portion of intestine is then sutured with care to the edges of the wound. The ligatures retain the gut in a flexed condition so that a spur is made between the upper and lower portion of the tube. Antiseptic dressings are then applied, and if three days have elapsed before the opening is made into the colon, inflammatory adhesion between the intestine and the belly wall will have occurred. Incision is then made into the bowel without anæsthesia.

The intestinal wound should correspond with the long diameter of the bowel and should be about half an inch in length. The edges of the wound may subsequently be trimmed away so as to make a good sized

opening. The operation in the median line is conducted on the same principles.

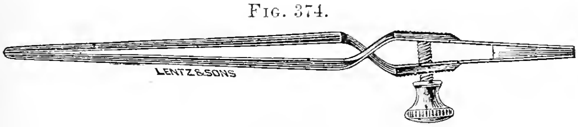
Resection of the Intestine.

Resection or excision of intestine is the removal of a portion of the bowel; and is often followed by immediate suturing of the ends of the tube thus left. The word enterectomy is often used to include operations of this sort upon the large as well as upon the small intestine. Strictly, it should be employed only for resection of the small intestine, while colectomy should be used when a portion of the large bowel is cut away. Resection of the intestine is adopted in gunshot and in stab wounds, when the bowel is too much injured to admit of simple suturing; in malignant and other strictures of the bowel; in gangrene of the intestine; and in some cases of incurable artificial anus. After gangrenous hernia resection may be necessary at the inguinal canal. At other times it is done after making a preliminary abdominal section, which is usually made in the median line.

The operation is divided into three stages: Separation of the bowel, excision of the intestinal tube, and suturing together of the cut ends. Adhesions between the portion about to be excised and other intestinal loops, or between it and the solid viscera, are a contra-indication to operation. The portion to be operated upon must be movable enough to be brought to the surface of the abdominal wound in order to permit the necessary manipulation.

In performing resection of the bowel the removal must include sufficient of the intestinal tube to reach healthy tissue above and below the seat of the disease. The intestinal contents, whether feces or gas, should be pressed out of the portion of the tube to be operated upon, and clamps should be placed above and below the field of operation.

FIG. 374.



Clamp for resection of bowel.

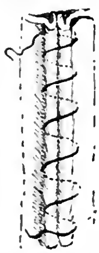
The bowel is then cut loose from the mesentery and the clamps successively released in order that the feces and gas retained beyond the clamp may be allowed to escape. In cases of obstruction the amount of material which will thus flow out is, of course, great. Much care should be taken that this material does not come in contact with the general peritoneal cavity, which may be separated from the field of operation by packing large, flat sponges into the abdominal wound. The portion of gut which the surgeon is about to cut off may, after it is detached at the lower end, be used to conduct away this accumulation of fecal matter into a vessel held alongside the patient. After the portion to be excised has been separated from the mesentery some surgeons prefer to cut out of the mesentery a V-shaped piece in order to get rid of the redundant mesenteric tissue. If this is done it is necessary to unite carefully the edges of the mesentery by overlapping them and applying sutures. It is not necessary, however, to make this V-shaped incision, since the redundant mesenteric tissue can be folded up by means of sutures and attached behind

the junction of the two ends of the intestine after they have been sewed together. This adds somewhat to the strength of the union.

Bleeding from the small vessels of the intestinal wall will follow excision of the diseased portion, and should be stopped by means of fine ligatures. Care must be taken not to devitalize the intestinal coats by compression of these vessels with large hæmostatic forceps, which grasp a great deal of tissue. Small-pointed arterial forceps should be used, and only the vessels enclosed in their grasp.

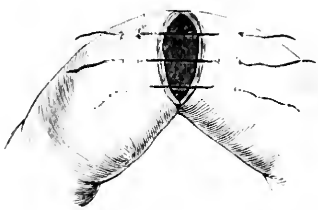
The most important and tedious step in enterectomy is stitching together the cut tube, which must be well done in order to prevent extravasation of feces into the general peritoneal cavity after the abdominal wound has been closed. Fine twisted silk makes the best sutures. They should be carried through the peritoneal and muscular coats, but should never perforate the mucous membrane so as to enter the lumen of the bowel. If any sutures are inserted for the purpose of uniting the mucous membrane, they must be tied on the inside of the gut, and not come through to the peritoneal surface. The Lembert suture is probably the best form

FIG. 375.



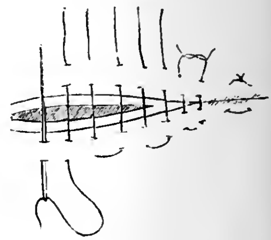
Continuous suture applied to intestine.

FIG. 376.



Lembert's suture. (BRYANT.)

FIG. 377.



Quilt suture.

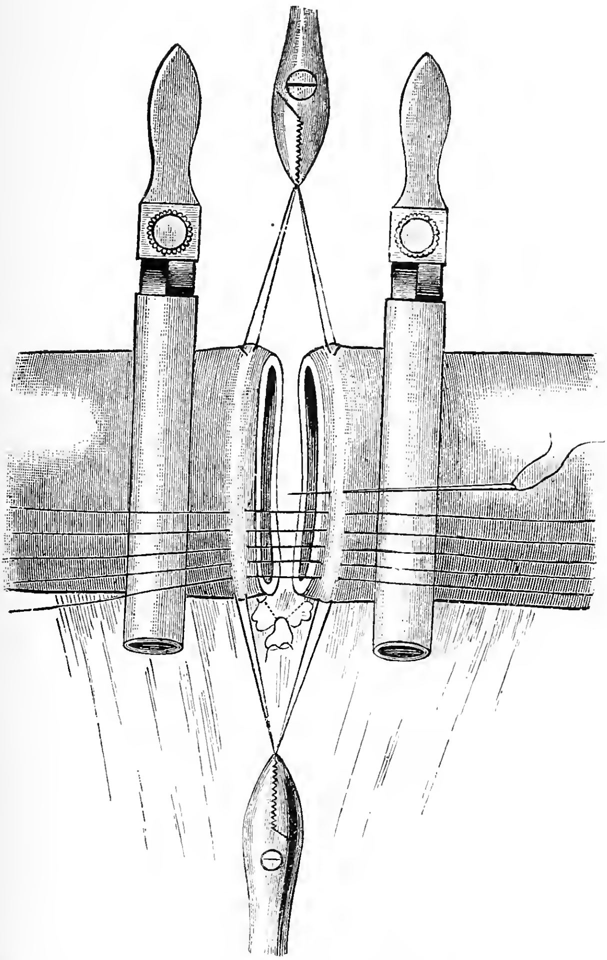
to use after resection of the intestinal tube. After the insertion of these sutures the continued suture may be used as an additional means of support at any dangerously weak spot in the bond of union. The quilt suture is another satisfactory method.

The sutures may be inserted while the clamps are upon the intestines, or some liquefiable cylinder, such as a long plug of cocoa-butter, may be inserted into the cut ends of the tube, and the sutures placed while the bowel is thus distended. A rubber bag, which can be distended with air, will answer the same purpose. Such devices are, however, not absolutely necessary.

The least point of leakage at the place where the enterorrhaphy is made will, of course, destroy the success of the operation, and will probably give rise to fatal peritonitis. In order to make the point of union still more perfect, Senn has proposed taking grafts of omentum and applying them along the suture line. He cuts out a small strip of omentum about two inches in width, and long enough to go around the gut. He keeps this in a warm antiseptic solution (sublimate, 1 to 2000), until he is ready to apply it around the junction as a sort of collar. The ends of the graft are stitched to the mesentery; and as the graft is aseptic it becomes united to the gut at the seat of operation. To make the graft more readily adhere, the peritoneal surface of the bowel may be slightly scratched with a needle point to cause rapid exudation of lymph.

The bowel thus prepared and sutured is returned into the abdominal cavity, for these manipulations have been done, of course, outside the abdomen, and the wound closed in the ordinary manner. If there is any doubt about the perfection of the enterorrhaphy, it is well to stitch the repaired gut to the edge of the wound. Then, if one of the sutures becomes untied, or a leak occurs, it will be at once discovered; when opening of the abdomen, irrigation and drainage may be promptly instituted.

Fig. 378.



Drawing to show method of suturing bowel after resection. (Greig Smith.)

If it is impossible to complete the resection in a case where this has been attempted, an artificial anus must be made by attaching the wounded intestine to the abdominal wall. If colectomy is anticipated when the operation is begun, it may be better to make a lateral rather than a median laparotomy. After such lateral opening has been made, which may be

small for exploratory purposes, it is not improper to do the operation through another incision, made in the median line, if the lateral one is found disadvantageous.

Intestinal Anastomosis.

This term signifies the construction of a permanent orifice between two portions of gut, so as to exclude the intervening portion from conducting the feces. When intestinal anastomosis is established between the jejunum and the ileum, the term jejuno-ileostomy is used. Ileo-colostomy is the construction of an orifice between the ileum and the colon, while gastro-enterostomy is applied to the creation of an opening between the stomach and a portion of the small intestine.

Intestinal anastomosis is indicated in obstruction of the intestines and in such malignant strictures as cannot be overcome or removed with safety. Apposition of the tubes between which the orifice is to be made is maintained by decalcified bone plates with central openings, or by elliptical rings of catgut or rubber. After these have served their purpose in keeping the serous surfaces in contact, they are either dissolved in the

Fig. 379.

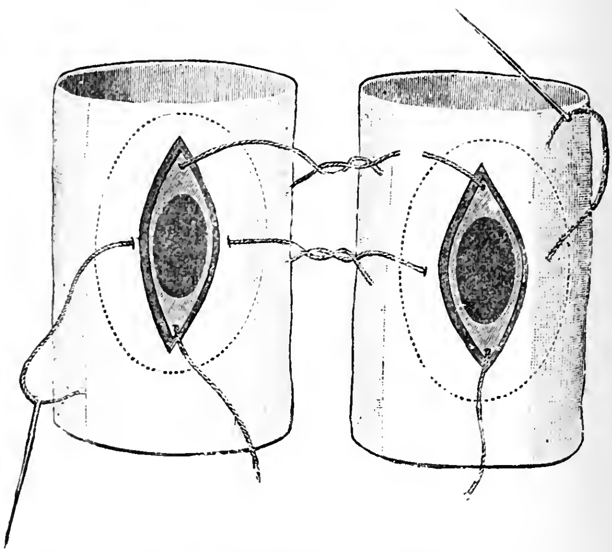


Diagram of method of using decalcified bone plates of Senn. (Greig Smith.

intestinal fluids, or, as in the case of rubber rings, pass through the bowels and escape from the anus undigested. In using the rubber rings it is customary to cut them at one point and unite the cut ends with catgut, which becomes dissolved and allows the rings to pass through the bowel straightened out and not as a cylinder. The use of plates or rings adds greatly to the safety of the operation of intestinal anastomosis. In suturing the apposed tubes a preliminary scratching of the peritoneum with a needle point will add to the certainty of the results.

Spring clamps are put upon the intestine above and below the seat of

operation after the intestinal contents have been squeezed out, as in resection. A point must be selected which will not cause dragging upon the mesentery or the bowel when the surfaces are put together. An incision from two to two and a half inches long is made in each portion of the gut, corresponding with its long diameter, and on the side opposite to the mesentery. Through these are passed into the lumen of the bowel the catgut or rubber rings, to each of which four sutures are attached or fastened. The lateral threads are carried through all the coats of the intestinal wall, while the threads at the end of the elliptical rings come through the wound. The ends of the corresponding threads are then tied upon the peritoneal surfaces of the apposed coils of gut. The opening in the centre of the ring prevents obstruction of the intestinal flow from one coil to another.

Intestinal anastomosis may be employed instead of a circular suture after resection. In this case the two cylinders are laid side by side, and the walls at the cut ends are turned in and sutured in a straight line across the extremity. After this a new opening is made and the apposition rings adjusted.

Fig. 380.

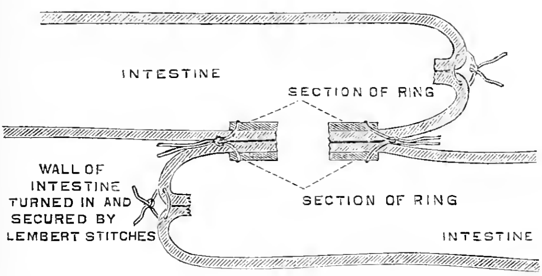


Diagram showing position of decalcified bone plates in intestinal anastomosis after resection of bowel.

The mere slit, made for the insertion of the rings and for the new orifice between the intestinal tubes, seems at times to give too small an orifice for the ready passage of feces. It probably contracts during cicatrization. It is possible that trimming away the edges of the intestinal incision so as to make an elliptical hole in each cylinder of gut will obviate this condition.

Diseases and Injuries of the Liver.

Laceration and other wounds of the liver may be indicated by local pain, jaundice, clay-colored stools, bilious vomiting and sugar in the urine. The symptoms vary with the locality and extent of the injury. The treatment is immediate abdominal section with suturing of the liver, and ligation or the use of the actual cautery to stop bleeding.

Abscess of the liver is especially frequent in tropical countries, but is also met with elsewhere. The suppurative process not infrequently gives rise to multiple abscesses. The pus which may originally be formed at some distance from the surface of the liver, may be evacuated spontaneously into the chest, abdomen, or bowel, or upon the exterior of the body. The

symptoms are rather negative, but increased hepatic dulness associated with pain and tenderness is suggestive of the possibility of abscess.

Hydatid cysts give rise to symptoms similar to abscess. The peculiar fremitus, which is so characteristic of the presence of this form of cyst, is often absent in hepatic hydatid cysts. Suppuration of these cysts is not uncommon. Then the symptoms are identical with abscess from other causes. Fluctuation is only perceptible in abscess and hydatid disease when the collection is large and near the surface.

The best treatment of hepatic abscess is laparotomy followed by incision of the abscess (hepatotomy) and drainage by a tube left in the wound. It is unwise to wait for the occurrence of adhesions between the liver and the belly wall with the idea of incising or aspirating the abscess through the parietes, because fatal rupture may take place before adhesion occurs. Moreover, there is often no means by which the surgeon can be sure of the existence of adhesion between the liver and abdominal wall. An abdominal incision should be made over the tumor if there be one. If adhesions of the liver to the belly wall are found to exist after this incision has been made, it is wise to close the exploratory wound and to open the abscess by a new cutaneous cut carried through the adherent area. In other cases the abscess is punctured, a finger inserted, and the liver drawn up to the abdominal wound in order that the abscess cavity may be evacuated without pus escaping into the peritoneal cavity. When this abscess has been emptied the finger should explore its interior and rupture any neighboring abscesses, so that all will empty themselves through the original opening in the liver. A weak antiseptic solution is used to wash out the suppurating cavity, after which the edges of the abscess wound are stitched to the skin, and a large drainage-tube of rubber inserted. The peritoneal cavity should be thoroughly washed out with warm sterilized water if it has been soiled, and the usual dressings applied. Pus should be sucked out of the abscess cavity by means of a syringe every day, and possibly irrigated with a weak antiseptic fluid. Hydatid cysts should be treated by incision and suturing to the belly wall in the same manner as abscesses.

Malignant Diseases of the Liver.

A malignant tumor of the liver, if single, may be removed by laparotomy. It is unusual, however, to find a single malignant nodule, since the symptoms are scarcely prominent enough to suggest exploratory laparotomy until the disease has advanced far enough to cause multiple tumors or large and immovable growths.

Diseases and Injuries of the Gall-bladder.

Rupture and wounds of the gall-bladder, because of the inflammation caused thereby, are nearly always fatal unless treated by surgical means. The exudation of plastic lymph as a concomitant of a localized peritonitis, may occasionally circumscribe the inflammation and thereby prolong life, or even prevent the fatal issue.

The treatment, however, is clear. It consists in opening the abdomen and stitching the edges of the wound in the gall-bladder to the skin, as in the ordinary operation of cholecystotomy.

Cholecystotomy.

Cholecystotomy, or incision of the gall-bladder, is performed for the extraction of gall-stones, for the treatment of dropsy and empyema of the gall-bladder, for obstruction of the common bile-duct, and in cases of rupture or wounds of the gall-bladder. Gall-stones give rise to attacks of hepatic colic, the pain of which is often agonizing. Inflammation, suppuration, and gangrene of the gall-bladder may occur as a result of the presence of stones in the bladder, while their passage into and arrest in the biliary passages may cause obstruction of the cystic, hepatic, or common bile-duct. Such obstruction, if involving only the cystic duct, gives rise to local symptoms, such as distention of the gall-bladder, followed, perhaps, by inflammation, gangrene, and the occurrence of biliary fistule. By sloughing of the wall of the gall-bladder and surrounding tissues, gall-stones may pass into the lungs, bowels, and peritoneal cavity. Fatal peritonitis is a complication which may be thus excited. If gall-stones become impacted in the common bile-duct, jaundice and cholæmia result in addition to local pain and inflammation.

Stones lying in the gall-bladder and not becoming entangled in the duct, may give rise to no special symptoms and remain unnoticed for years.

Dropsy, or empyema, of the gall-bladder is usually due to stones, but may be caused by hydatids or intestinal worms plugging the duct, or to pressure from some tumor connected with the neighboring viscera. The distention may be so great as to cause the bladder to fill nearly the entire abdomen. In such cases the walls are apt to be thinned.

Stricture from inflammation of the mucous membrane of the duct may give rise to purulent distention of the gall-bladder. Thickening, ulceration, and perforation of the walls may occur as a result of suppurative inflammation within the gall-bladder.

The diagnosis of these pathological changes in the gall-bladder is made by the existence of a tumor in the right hypochondriac region. It may be fluctuating, or so tensely distended as to be hard. It may be pear-shaped or globular, but usually increases in size in an oblique direction from the hypochondrium toward the umbilicus. Jaundice is frequently absent, because the common bile-duct is unobstructed.

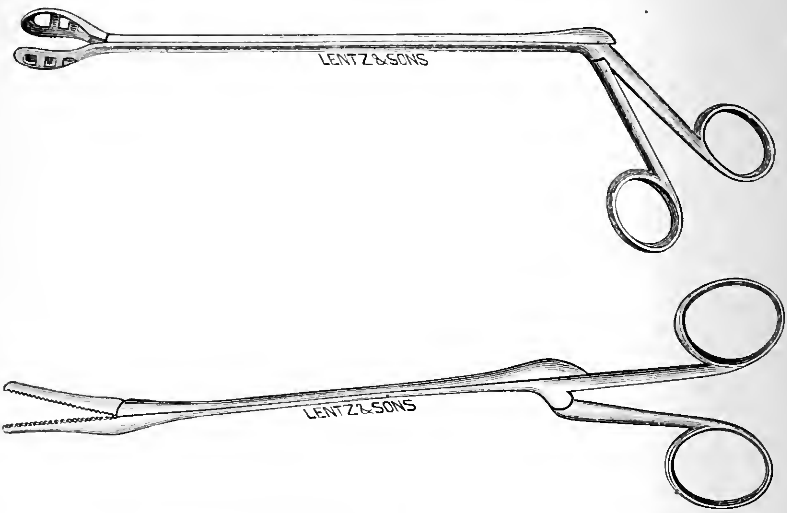
The diagnosis between distention of the gall-bladder, cystic tumor of the kidney, movable kidney, and inflammation about the pylorus or head of the pancreas is difficult.

The operation of cholecystotomy is demanded in wounds, dropsy, and empyema of the gall-bladder. It is often required in cases of gall-stones, but in this condition should not be performed until the frequency of hepatic colic, the exhaustion of the patient from cholæmia, or the evident existence of a greatly distended bladder filled with stones indicates its necessity.

The operation is more successful in cases in which jaundice is not present, because bile in the blood (cholæmia) depresses the patient's forces and renders the bleeding more profuse. The operation, however, must often be done in cases where jaundice exists. Opening the gall bladder and simply stitching its wall to the abdominal parietes is the operation called cholecystotomy. Removal of gall stones after such an incision is cholelithotomy, while, if it is necessary to crush the stones before removing them, the procedure is termed cholelithotrity.

The incision should be made over the fundus of the gall-bladder, which corresponds with the tip of the cartilage of the tenth rib on the right side, or it may be made over the tumor, if one exists. The incision should be vertical. If the bladder is greatly distended some of the fluid may be drained away by an aspirator before an incision large enough to permit insertion of a finger is made. Care should be taken, by packing wet sponges around the seat of the operation, to prevent the bile flowing into the peritoneal cavity. The gall-stones should be removed with a scoop or forceps, or crushed with appropriate forceps.

Fig. 381.



Tait's cholelithotomy forceps.

The surgeon must recollect that the walls are thin and easily torn. If laceration occurs it may be necessary to remove the entire bladder (cholecystectomy). If the stone is immovably fixed in the duct it may be nibbled away with Tait's forceps. Possibly it may be broken up by thrusting a needle into it. After the stones have been removed, or the dropsical fluid or other contents evacuated, the gall-bladder must be sutured to the edges of the belly wall. The stitching should be by a continuous suture of silk and pass through the skin, peritoneum, and bladder wall.

A drainage-tube, preferably of rubber, should always be inserted and the belly wound closed around it. The bile which flows from the tube may be conducted into a bottle lying alongside of the patient. A piece of rubber dam may be fixed around the orifice of the tube so as to prevent the bile coming into contact with the wound, and a mass of absorbent material placed over the orifice. If all stones have been removed so that the bile flows through into the intestine, the fistule made by the operation will finally close. If such is not the case it may become necessary to make a permanent opening between the intestine and bladder by subsequent operation. Such an operation is entero-cholecystostomy.

Biliary fistules from spontaneous evacuation of the bladder contents will not close unless the bile is conducted into the intestine by this same

operation; after which plastic operations upon external openings may be made if closure does not take place.

Diseases and Injuries of the Spleen.

Rupture or wounds of the spleen should be treated by abdominal section and suturing. When the damage done is very great, removal of the spleen (splenectomy) may be demanded. Cyst of the spleen is to be treated by laparotomy and incision followed by drainage. The operation of incision into the spleen is termed splenotomy. Excision of the spleen or splenectomy, may be required in some cases of movable spleen, in hypertrophy of the spleen, when it is not leucocythæmic, and in tumors.

The operation is performed by an incision through the left semilunar line. The attachments of the organ are divided and ligated, clamps in some instances being required before the adhesions are cut. Hemorrhage is the great danger, hence it is necessary that each stump should be tied separately.

Diseases and Injuries of the Pancreas.

Abscesses and cysts of the pancreas should be treated by laparotomy, incision of the abscess or cyst, and the establishment of a fistule by attaching the edge of the sac to the abdominal incision. This is done because of the necessity of providing for the escape of the pancreatic fluid, which would otherwise flow into the peritoneal cavity. The incision should be made over the tumor.

Diseases and Injuries of the Uterus and its Appendages.

Injuries of the abdomen seldom involve the uterus unless it be pregnant, or in cases where the injury is so extreme as to do damage to many of the abdominal and pelvic organs. A pregnant uterus has by error been tapped for abdominal dropsy. The wound in such cases is apt to cause abortion. If serious symptoms or peritonitis should arise from this, or any other uterine injury, abdominal section should be performed, and the condition found treated on general principles, such as suturing of the wound, irrigating the peritoneal cavity, and drainage.

Fibro-myomatous tumors of the uterus are quite common growths, especially in the negro. They are often called fibroids because they resemble fibromas. They are, as a rule, however, largely myomatous in their histological features; and are the most common of uterine tumors. If they develop beneath the peritoneum they are called subserous, or subperitoneal fibro-myomas; if under the mucous membrane of the uterus, submucous fibro-myomas; while those developing within the substance of the uterus are called interstitial or intra-mural tumors.

These tumors are interesting, surgically, particularly when they are developed under the peritoneum, as then they may be confounded with other growths until the abdomen is opened. A uterine fibro-myoma gives rise to pain, uterine hemorrhage, and a hard irregular tumor, which can often be felt through the abdominal wall.

Ergot is given for the relief of the hemorrhage and to cause uterine contraction, by which it is hoped the growth may be gradually forced through the uterine cavity toward the vagina, where it is more accessible

to removal. The submucous form sometimes has quite a long pedicle. If this is the case the growth may be removed by the écraseur, introduced through the vagina. Sessile growths of this sort are treated by scraping away with a spoon having a saw-like edge, after a preliminary dilatation or incision of the os has been performed, so as to facilitate the intra-uterine manipulation. The intra-mural fibro-myomas may also, at times, be enucleated by scraping or incising the internal uterine wall after dilatation or incision of the os.

Subserous tumors are amenable to operative treatment only by abdominal section. The growth may then, perhaps, be enucleated from the uterine tissue; or the uterus, if occupied by enormous or numerous growths, extirpated (hysterectomy).

Apostoli and others have earnestly advocated the treatment of these uterine tumors by the application of galvanism. Removal of the ovaries to bring on the menopause, and thereby stop the monthly congestion of the uterus, which aids in the growth of these tumors, is often adopted.

Fibro-cystic disease of the uterus is a rare condition, and need not be discussed.

Malignant disease of the womb is most frequently met in the neck. For its treatment, amputation of the neck by the introduction of instruments into the vagina, is often performed. The diseased portion may be eaten away by chloride of zinc or other caustics. The best treatment, probably, is removal of the entire uterus by the operation called vaginal hysterectomy. In this operation the uterus is pulled down by toothed forceps, and an incision made through the vaginal mucous membrane in front and behind, so that the operator's fingers can be carried into the peritoneal cavity to drag down the entire organ. The broad ligaments are then ligated, or clamped with large hæmostatic forceps; and the uterus cut loose. The peritoneum and mucous tissue at the top of the vagina fall together as the uterus is withdrawn. If clamps are used to control the vessels of the broad ligament, they are taken out at the end of twenty-four or thirty-six hours.

Tumors of the Ovary.

PATHOLOGY.—These growths are of importance to the surgeon, because a diagnosis is often required to be made between them and other abdominal conditions; and because the abdomen has often been opened for some other condition, and an ovarian cyst or tumor unexpectedly found to be the cause of the symptoms.

Ovarian tumors are most commonly cystic, which may be unilocular, or multilocular. What are called unilocular cysts are not infrequently multilocular cysts with one cyst greatly developed. Sometimes such cystic tumors are in part solid. Tumors which are dermoid cysts, wholly or in part, are not very rare in this locality. Tumors of the broad ligament, called parovarian tumors, may be cystic or solid. Solid tumors of the ovary are rare, and when found are usually malignant.

SYMPTOMS.—Ovarian cysts when small produce no symptoms. If they increase in size they displace the uterus forward, or backward, or laterally, and probably depress it a little. This takes place when the tumor is small enough to be contained in the pelvis. When, from increase in size, it rises into the abdomen, such changes are not apt to be present.

The symptoms of ovarian tumors, which are now to be described, are not very reliable, for similar symptoms may occur in other diseases, and

ovarian cysts may be present without giving rise to them with sufficient distinctness to be of value in diagnosis. A small, rather globular mass, either firm or fluctuating, and probably movable, is found sometimes on one or other side of the belly. As it increases in size a feeling of discomfort, frequent urination, constipation, and œdema of the limbs from compression of the veins may arise. Pain from pressure on the sacral or lumbar plexus may occur and be reflected down the legs. Nausea, vomiting, colicky pains, and, perhaps, diarrhœa, are not improbable. Ascites from interference with circulation in the portal vein is quite usual, and hemorrhoids from a similar interference with the venous return are annoying complications. Albuminuria also may be present, and dyspnœa from abdominal distention due to the bulk of the tumor, and from the peritoneal dropsy just mentioned, may be very distressing.

When the cyst becomes large enough to distend the abdomen, greatly and particularly when the cyst is unilocular, it very much resembles peritoneal dropsy, or ascites occurring from visceral disease. A differential diagnosis is then a matter of great importance. Multilocular cysts are not so liable to make a diagnosis difficult, because they usually have an irregular surface, and because fluctuation is more marked in some places than in others. The fluctuation wave does not cross the whole abdomen, but is limited to various portions of it, unless one of the cysts in the multilocular growth is very much larger than the others. A unilocular cyst

Fig. 382.

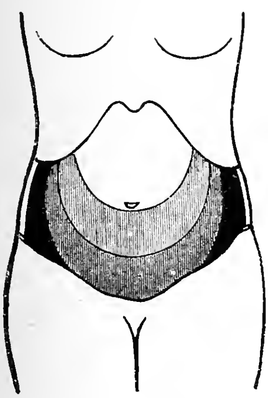
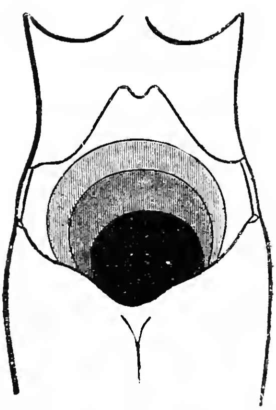


Fig. 383.



Diagrams showing development of areas of dulness in ascites (Fig. 382) and in ovarian tumor (Fig. 383). The darker shading indicates an earlier stage of disease. (Greig Smith.)

has a smooth outline, is elastic, and gives a fluctuation wave over its whole extent. This last symptom is very like that given by ascites. Dulness on percussion exists over the tumor whether it is unilocular or multilocular. In ovarian dropsy, a term often used to signify an ovarian cyst, the area of dulness is circular, with the convexity of the circle directed upward near the middle line, with resonance extending downward upon each side.

In ascites the dull area gives a crescentic line with the concavity upward, while resonance is notably situated between this line and the stomach. The dulness of ascites is changed by turning the patient on her side.

This does not take place in ovarian dropsy, where the line is practically unchanged by such movement. It should be remembered that when an ovarian cyst is accompanied with ascites, due to pressure of the cyst upon the venous trunks, there may be dulness in the flank, fluctuation across the whole abdomen, because of the complicating ascites. This will destroy the outline of the resonant area indicative of ovarian cyst.

In ovarian cysts there is often a peculiar heaping up, as it were, in the middle line, which is due to the greater distention in the middle portion of the abdomen; but in ascites gravity acting on the unconfined fluid causes distention at the sides of the abdomen and flattens the front of the belly. In ascites, moreover, there is apt to be evidence of disease of the heart, or of the kidney, liver, or some other abdominal organs, with perhaps œdema of the arms and face. Œdema of the legs does not aid much, because, though frequently occurring in cardiac, renal, and liver disease, it also exists in cystic tumor of the ovary, from pressure of the growth on the caval and iliac veins. When abdominal dropsy exists in addition to the ovarian cyst, the diagnosis of a tumor in addition to the ascites may sometimes be made by quick and forcible pressure of the fingers upon the abdominal wall. The sudden pressure or tap causes the peritoneal fluid to be pushed aside and the fingers come abruptly upon the ovarian cyst or other growth. This would not occur if ascites alone existed, nor if a large ovarian cyst without accompanying ascites were present. The fluid of ascites is usually thin yellow serum. The fluid of ovarian cysts is frequently brownish in appearance.

Encysted dropsy of the peritoneum is difficult to diagnose from ovarian cyst. A differential diagnosis is often impossible. Cysts of the broad ligament resemble ovarian tumors in their symptoms, and in their treatment, except that tapping is sometimes curative in the former. Ovarian cysts should seldom, if ever, be tapped, and then tapping is not curative. As other growths, cysts of the ovary may become adherent to the intestines, solid viscera, and abdominal wall. The presence of adhesions cannot with certainty be made out before the abdomen is opened.

Rupture of an ovarian cyst may occur, and the fluid, if it escapes through a small opening, may give rise to no special symptoms; but if it is suddenly evacuated into the peritoneal cavity in large quantities, collapse and death may occur at once. In any case, the escape of fluid may give rise to peritonitis; this it is sure to do if the contents be purulent. Twisting of the pedicle may occur from rotation of the tumor, and inflammation and gangrene of the growth take place as a result.

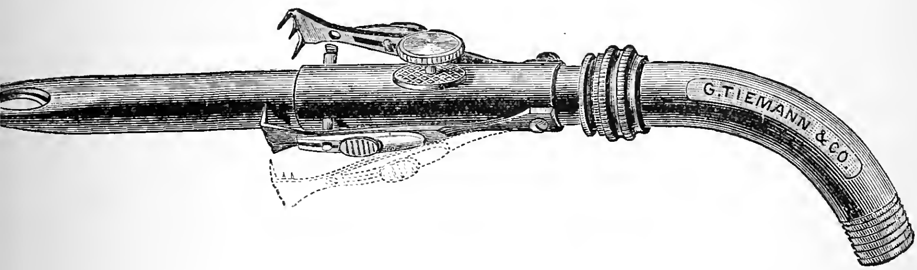
Treatment.—The only treatment for ovarian cyst is removal by laparotomy, which, at the present day, is exceedingly safe if the operation be properly done. Tapping the cyst, so often employed formerly, is not justifiable as a general course of treatment. It may be employed to prolong life, when removal of the tumor is impossible; or it may be done in order to make the patient comfortable until the operation, then unadvisable, can be done. For example, the existence of an acute disease may render immediate ovariotomy impossible. Then temporary relief from tapping may be justifiable. There is no advantage in it in order to make an examination of the fluid as a means of diagnosis, since such examination is fallacious. Since the only proper treatment cannot be undertaken without opening the abdomen, exploratory incision, followed by immediate removal of the ovarian cyst, if one is found, is the correct surgical procedure.

Peritonitis, due to rupture of a cyst, or to the occurrence of suppura-

tion within the cyst, indicates immediate operation. Ovarian cysts have been successfully removed while the patient was pregnant.

The incision for removal of an ovarian cyst should be about three inches long in the middle line and midway between the navel and the pubes. It is wise to go no nearer to the pubes than two inches, to make sure that the bladder be not injured. The incision can always be enlarged upward with safety at any stage of the operation. If the surgeon carries the abdominal incision above the navel it is best to carry it around the outside of the navel on one side rather than to go directly through it. All hemorrhage of the abdominal wound should be stopped before the

Fig. 384.



Tait's ovariotomy trocar.

peritoneum is opened. The cyst is then tapped with a trocar before the adhesions, if there be any, are broken down, and the contents of the cyst allowed to flow through the trocar. The wall of the sac should be drawn out of the wound to prevent extravasation of the cystic fluid into the peritoneal cavity.

Fig. 385.

Thornton's T-shaped forceps.

The adhesions are then gradually torn through with the fingers, or, if very firm, are divided with a pair of scissors, perhaps after previous ligation. Every precaution to prevent hemorrhage is taken. The wound made by the trocar in the sac should be closed with a T-shaped hemostatic forceps, to prevent the escape of cystic fluid into the peritoneal cavity.

Injury to the bowels must be carefully avoided by detaching the adhesions from the intestinal wall with caution. Vascular adhesions must be ligated in a way similar to that adopted for tying a pedicle. The pedicle of the growth is found after the sac has been separated from its adhesions and drawn through the wound, and must be ligated before the sac is cut away. This is best done by transfixing the pedicle with a blunt needle and thereby carrying a double silk ligature through it, or by thrusting a pair of closed hemostatic forceps through the pedicle, by which the ligature is seized in the middle and drawn backward through the opening made by the forceps. An aneurism needle does very well for this purpose. The loop of the suture is then cut, leaving two portions of silk lodged in the pedicle. After a twist around each other has been given to the threads at the point where they perforate the stump, each half of the stump is tied sepa-

rately. One of the ligatures is then carried around the whole pedicle, making the ligation more secure, and the ends, by means of needles threaded upon them, may be carried through the base of the pedicle on the side away from the tumor, and tied in such a way as to anchor the whole ligature. This prevents the possibility of its slipping from the stump when the tumor is removed.

Various forms of interlocking ligatures have been devised for use upon the pedicle. One of the best is the Staffordshire knot. It is made by carrying a double ligature through the middle of the pedicle, bringing the loop, which is on one side of the pedicle, over the tumor, so as to be on the same side as the two free ends, and then passing one end through the loop. One end is thus placed over, the other under, the loop. The two ends are then pulled, until the loop is tightened, and then tied with a flat knot. The cyst is then cut off outside the ligature, and the ligated stump dropped into the belly. The toilet of the peritoneum must be carefully performed. Drainage should be instituted, if there is necessity for it by reason of pus escaping from the sac into the cavity, or because of oozing of blood from many small points which cannot be ligated.

Solid tumors of the ovary should be removed by laparotomy and excision. The handled screw of Tait may be inserted into the mass in order to render its manipulation convenient.

Diseases of the Fallopian Tubes.

Tubal disease may arise as a consequence of uterine and pelvic inflammations and of gonorrhœa. Inflammation of the tubes is called salpingitis. Suppuration within the tubes is usually, it is believed, a sequence of gonorrhœa, and is called pyosalpinx. Injury of the Fallopian tube, or obstruction to the escape of menstrual fluid from the vagina or uterus may give rise to distention of the tube by blood (hæmato-salpinx). A collection of serum in the tube causes the condition called hydrosalpinx.

Tubal disease is of importance to the surgeon because it is often the cause of pelvic and abdominal suppuration. Purulent peritonitis is often on examination found to be due to rupture of the Fallopian tube, which has been the seat of suppurative inflammation.

The symptoms of tubal disease are pain, especially severe upon exertion or coition, tenderness in the ovarian region, painful and irregular menstruation and various distressing symptoms referred to the pelvis and uterus. Symptoms formerly attributed to pelvic cellulitis were probably in the majority of cases indicative of tubal disease. Pelvic cellulitis without disease of the uterine appendages is now believed to be rare. In disease of the tubes vaginal examination will probably reveal the presence of a fluctuating oblong tumor through the roof of the vagina. Such a tumor may exist upon one or both sides, and may be movable or adherent. The elongated shape of a distended tube differs from that of a small ovarian cyst. Pyosalpinx sometimes gives rise to rigors and febrile conditions.

The treatment of diseased tubes is largely operative. Hæmato-salpinx may, perhaps, be excepted from the rule that diseased tubes should be removed by abdominal section. When the tube contains pus there is great danger of spontaneous or accidental rupture, and of thus creating

purulent peritonitis. Hence removal is demanded. The excision of tubes distended with serum is usually judicious treatment.

The operation of salpingectomy, or removal of the tubes, is a simple one, and consists in making a two-inch incision in the middle line of the abdomen, through which one or two fingers are introduced. The adhesions, which are often present, are carefully torn and the diseased Fallopian tube drawn through the abdominal incision. The ovary should be brought out along with the tube and afterward the pedicle secured and tied with silk. Great care must be exercised in operating for pyosalpinx to avoid rupture and escape of pus into abdomen or pelvis. If this accident happens, as it may, because of the firmness of the adhesions, the abdominal and pelvic cavities must be well irrigated, and subsequently drained by a glass or rubber tube being left in the wound. An interlocking ligature about the broad ligament which forms the stump is probably the safest.

Oöphorectomy, or removal of the ovaries when not the seat of cystic disease or other gross lesion, has been employed in the treatment of ovarian neuralgia, and of insanity, epilepsy, and menorrhagia accompanying fibro-myomatous tumors.

The term ovariotomy is usually employed to indicate removal of ovaries which are the seat of cystic or solid tumors. It will be seen, however, that oöphorectomy, which etymologically means removal of the ovaries, has the same signification, though the terms are usually used with a distinction. Normal ovariotomy is sometimes employed instead of oöphorectomy. The student should observe that the latter word is not pronounced as though its first syllable was "ou."

Hernia.

Definition.—Hernia, or rupture, is a protrusion of any portion of the abdominal or pelvic contents through an abnormal opening in the wall of these cavities, not a recent penetrating wound. The tumor is usually covered with integument. Such is not the case, however, in hernia through the diaphragm, nor in hernia into the vagina or rectum.

The term "hernia" is sometimes applied to a protrusion of other structures through an opening, such as hernia of the brain, which is a protrusion of cerebral and inflammatory tissue through an opening in the skull, and hernia of the iris, which is a protrusion of the iris through an opening in the cornea.

When the word hernia is used alone it refers to a protrusion of the abdominal and pelvic contents.

Causes.—Hernia is apt to occur where the wall of the abdomen or pelvis is weakened by the passage of some normal structure, such as the spermatic cord, the round ligament, the femoral vessels, or by a cicatrix left after a wound. A protrusion through a recent wound is not called a hernia, but a protrusion occurring at the cicatrix of an old wound is a hernia.

The predisposing causes of hernia are a long mesentery, a patent funicular portion of the vaginal tunic or canal of Nuck, congenital defects in the wall of the belly, relaxed muscles from pregnancy or emaciation, and cicatrices.

The exciting causes are muscular exertion, such as occurs in lifting heavy weights, straining at stool, and in the repeated compression of the viscera which occurs in stricture of the urethra, phimosis, stone in the

bladder, and chronic cough. These conditions give rise to hernia because the muscular contraction involved causes a diminution of the cubical space in the abdomen and pelvis and tends to thrust the contents of these cavities through any weak portion of the wall.

PATHOLOGY.—The ordinary seats of hernia are the inguinal canal, the femoral canal, the umbilicus, and cicatrices left after laparotomy or accidental penetrating wounds of the abdomen. Hernia at the obturator foramen, at the great sciatic foramen, or through the diaphragm into the chest is rare. A diaphragmatic hernia may occur through any of the normal openings in that muscle, or through a congenital defect. Hernia in the lumbar region, into the perineum, or into the space between the vagina and the ramus of the ischium is rare, as is also hernia into the rectum and vagina.

A hernial tumor usually pushes before it the parietal peritoneum, which is stretched or undergoes interstitial growth by force of the descending tumor, and forms a sac. The contents of the sac are usually intestine or omentum, but almost any of the abdominal or pelvic organs may be contained in the hernial protrusion. Outside of the sac are found the fascias and muscular structures pertaining to the region in which the hernia occurs.

When hernia occurs into the vaginal tunic of the testicle because the funicular portion in the inguinal canal has not become obliterated, the condition is called a congenital hernia. Here there is no true hernial sac or protrusion of the parietal peritoneum, since the canal of peritoneum already existed as an unclosed fœtal structure.

The sac of a hernia has a body, a neck, and a mouth or orifice, through which the hernia enters the sac. The sac is usually pear-shaped or globular, but may assume almost any form. It may be divided by partitions into separate chambers, and in one or more of these chambers there may be serous fluid. The sac walls of old hernias are often very much thickened ; sometimes they are irregularly thinned in places. The neck of the sac in a recent hernia is more or less folded or plaited, but in old cases it usually has become smooth, indurated, and thickened by inflammatory deposits.

When the contents of a hernial sac consist entirely of intestine the hernia is called an enterocele. A hernia consisting of omentum is an epiplocele; while one in which the contents are both intestine and omentum is known as an entero-epiplocele.

The ovaries and bladder and portions of the solid viscera are found in some large hernias, but usually it is the small intestine with or without a portion of the omentum which is found in the hernial sac. In rare cases only a portion of the calibre of the knuckle of intestine enters the hernial sac, which in this case of course is small.

An untreated hernia may become exceedingly large, until several feet of gut lie outside of the abdominal cavity. The intestine, the mesentery, and the omentum of an old hernia usually become hypertrophied, and more or less adherent to each other and to the sac wall. A limited amount of serum is often found in the sac, and occasionally rice-like bodies composed of inflammatory lymph are present. If a hernia has been kept within the abdomen for a long while by a truss, the neck of the sac may become obliterated and the sac remain as a cyst filled with serous fluid.

When the protruded viscera can be pushed back into the cavity of the abdomen the hernia is said to be "reducible." When such is not the

case, and the protruded viscera cannot be reduced by manipulation, the hernia is called "irreducible." The word "incarcerated" is sometimes employed to indicate the condition of irreducibility; unfortunately it is also used occasionally as synonymous with "obstructed" hernia. The latter use of it seems to me improper.

A "strangulated" hernia is one in which the protruded viscera are so tightly grasped that it is impossible to push back the mass into the abdominal or pelvic cavities, and in which circulation of the part protruded is so impeded that inflammation or gangrene takes place. If the hernia which is strangulated contains intestine, the passage of the feces is also prevented by the compression of the gut.

In an "obstructed" hernia the intestine is obstructed with a mass of undigested food, or feces. It is irreducible, and occurs especially in old persons. The liability of such hernias to become strangulated or inflamed is very great.

An "inflamed" hernia is one in which the sac contents are in a condition of inflammation. This pathological condition is most common in small irreducible hernias, and is due to wearing an ill-fitting truss, or to violent exercise or injury. An inflamed hernia is apt to become strangulated.

In reducible hernia the hernial contents often return into the belly spontaneously when the patient lies upon his back. The sac, in recent cases, sometimes goes back at the same time that the intestine and omentum do. In most cases, however, the sac remains adherent to the surrounding structures after its contents have spontaneously, or by manipulation, been returned to their normal site.

A hernia becomes irreducible because of changes in the vicinity of the ring, in the protruded tissues themselves, or in the sac. The ring or opening may have become inflamed, and thereby contracted; the neck of the sac may have become elongated and its walls thickened; the protruded structures may, from growth or inflammation, have increased in size below the neck after their extrusion; adhesions may have occurred between the contents of the sac and the sac wall, or between various portions of the hernial mass; and, finally, bands of inflammatory tissue developed within the sac, or the fluid contained in it may interfere with the reducibility of the hernia.

A recent hernia may be strangulated by suddenly being forced through a small opening which instantly exerts great constriction. An old hernia may become strangulated by a sudden protrusion of a new portion of the intestine or omentum in addition to the previous mass; by swelling from inflammation of the omentum or of the mucous membrane of the intestine, or by increased size of the gut from obstruction with gas or feces. The constriction causing strangulation may be at the outside of the sac at the hernial ring, in the neck of the sac itself, or within the sac. In the last case the strangulation may be caused by inflammatory bands, or by openings between two portions of the hernia within which another portion may have become constricted. Strangulation may be acute or chronic in its course, according to the mechanism which produces it.

The compression of veins by the strangulation gives rise to venous congestion, followed by inflammation and gangrene. The paralysis of the muscular coat, which sometimes occurs, may interfere with peristaltic action and cause obstruction to the passage of the feces, although the lumen of the intestines is not entirely closed by the pressure. Strangulation may occur also in Littré's hernia, although the entire calibre of the

intestine is not constricted in this form of hernia. It is easily understood that the greater the swelling the greater the constriction, and that, at the same time, the increase of constriction thus caused tends to produce a further increase of swelling. A strangulated knuckle of bowel usually at first becomes red, then of a dark color, and finally black or gray. This last condition is often accompanied with ecchymotic spots. The swollen, sticky, and œdematous coats of the intestine exhale a fecal odor, and exude a dark fluid. Sloughing and perforation of the intestinal wall occurs as a later step, and is followed by fecal extravasation into the sac, which, if the patient lives long enough, ends in fecal abscess, and in the formation of a fistule between the gut and the external surface. Peritonitis occurs quite early after strangulation has taken place. The intestine soon becomes glued to the belly wall surrounding the hernial ring, and, therefore, in cases of fecal abscess, the extravasated feces are not apt to escape into the general peritoneal cavity. In the majority of cases, death takes place from exhaustion and peritonitis before fecal abscess and fistule have occurred.

Symptoms.—A feeling of weakness is often experienced by the patient before the hernial protrusion takes place. A fulness in the part is perhaps perceptible, and suggests the occurrence of hernia because it is at the locality where hernia is likely to occur. If the disease is gradual in its development, a small tumor, not larger than a finger-tip, may at length be noticed at the seat of this fulness, and is accompanied by a subjective sensation of weakness. When the patient lies down the tumor spontaneously disappears, because the protruded bowel or omentum slips back into its normal position. In other cases, sudden and painful protrusion occurs at one of the ordinary seats of hernia during straining at stool or violent exercise.

The hernial tumor is usually round or oval, and rather smaller at its base, which represents the seat of the neck of the sac. It is enlarged when the patient stands or coughs, but disappears under gentle pressure or when he lies down. Coughing causes an impulse in the tumor, which is very perceptible to the hand when grasping it. If the hernia consists of intestine alone, the tumor is smooth, elastic, tympanitic on percussion, and slightly gurgling when compressed. The impulse on coughing is marked. Rumbling from intestinal gases is present, and the patient has a dragging sensation at the seat of the tumor. Reduction is accompanied by a distinct gurgling, due to the escape of gases and liquid feces, and by a sudden peculiar croaking sound as the gut slips back into the belly.

If the hernia contains only omentum, the tumor is apt to be irregular and to have a doughy feeling; it shows less impulse on coughing, and when being reduced slips back gradually without any gurgling or croaking sound.

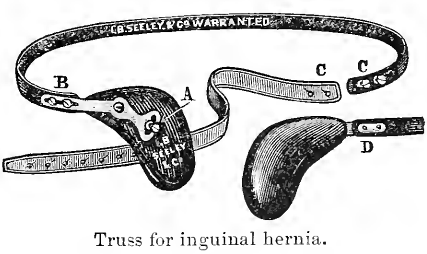
The symptoms of irreducible hernia are not unlike those already described, except in so far as these symptoms pertain to the possibility of the protrusion being pushed back into the abdomen. Colicky pains are rather characteristic of irreducible hernia. In some cases, where both intestine and omentum are contained in the sac, the gut is reducible, while the omentum is irreducible.

Strangulated hernia gives rise to very characteristic symptoms. The tumor becomes painful, tender, and tense, and a tympanitic note is given if intestine is contained in the sac. Impulse on coughing is lost. Pain is usually referred to the umbilical region, which is the reason that strangulated hernia has been so often mistaken for ordinary colic. If the constriction is not relieved the skin overlying the gut, which has become

gangrenous, assumes a dark hue and gives rise to a fecal odor. The sensation of pain is apt to cease if gangrene occurs. To the uninitiated this appears to be a good omen. The surgeon, however, knows that it is a sign of grave pathological change. The intestinal obstruction due to strangulation causes obstinate constipation and vomiting. Constipation is complete except that the lower bowel may be emptied of its contents during the earlier hours of the disease. In Littré's hernia constipation is not, as a rule, complete. Vomiting is violent and gushing without much retching. The vomited material is at first the contents of the stomach, then bile and the other fluids found in the upper part of the small intestine are ejected. Finally the ejection of a brownish-yellow fluid with the odor of feces indicates that the contents of the lower portion of the small intestine are being thrown up. This fluid is indeed feces, and to such vomiting the name "stercoraceous vomiting" is given. There is no flatus discharged from the rectum, but the contents of the large bowel may be evacuated either voluntarily or after the administration of an enema. The face becomes pinched and anxious; the pulse is frequent and weak and perhaps irregular; the tongue is furred and brown. There is profund collapse, and, later, exhaustion and death take place. Recovery after the formation of a fecal abscess and fistula due to gangrene of the gut does occur, but it is rare. In young persons and in recent hernia strangulation usually gives rise to acute symptoms, while, occurring in the irreducible hernia of old people, the strangulation symptoms are apt to be more chronic in their course.

Treatment.—The palliative treatment of reducible hernia is the application of a compress of gauze, or other material, to hold the intestine within the abdomen until a properly fitting truss can be obtained from the instrument-maker. A hernial truss consists of a pad held in place over the hernial ring by a spring around the pelvis. The truss varies in shape and size in accordance with the seat and character of the hernia, and should be made to fit comfortably, and to make only such pressure over the hernial opening as will retain the structures which are liable to protrude. If the patient can be seen by the instrument-maker a properly fitting truss is generally readily obtained. When, however, the patient lives at a distance from a large city the surgeon should send the instrument-maker the girth of the pelvis midway between the crest of the ilium and the great trochanter, describe the kind of hernia, tell on

Fig. 386.



Truss for inguinal hernia.

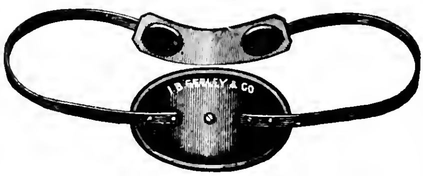
which side it exists, give the sex and age of the patient, and express his opinion as to the relative strength of the spring required. The truss should be adjusted while the patient is recumbent and the hernia reduced. It should always be worn when in the erect position, and should never

be taken off until he is recumbent. Many patients can go without their trusses at night because there is little tendency for the hernia to recur while they are lying down. Others require to wear a truss at night, but then it is not necessary for the spring to make as much pressure as during the daytime. Hence a weaker truss may be used. A truss at night is wise when the patient suffers from a cough. It usually takes some time for the patient to become accustomed to wearing the support, as is the case with those wearing an artificial limb or spectacles for the first time. The annoyance, however, is only temporary.

FIG. 387.

Truss for femoral hernia. This form is applied across the pelvis from the sound side.

FIG. 388.



Truss for umbilical hernia.

A properly fitting truss should permit the patient to go up and down stairs, and jump off a chair, for example, without permitting escape of the hernia.

If the pad of the truss irritates the skin, as it often does, the cutaneous surface may be sprinkled with lycopodium powder and bathed frequently with whiskey and alum.

The radical treatment of hernia consists in reducing the protrusion, obliterating the sac, and closing the ring. In young persons with small hernias, wearing a truss may induce sufficient inflammation of the peritoneum forming the sac to cause the latter's obliteration. This is especially true of congenital hernia, in which the unobliterated portion of the vaginal tunic very readily becomes adherent from the irritation caused by pressure of the truss.

In other cases the radical cure is only possible by operative interference. The radical treatment is especially employed in inguinal hernia. An incision is made over the tumor, the sac separated from the surrounding tissues, and the protruding viscera returned to the abdomen. Various means are employed for dealing with the sac so emptied and separated. Some operators invaginate it into the inguinal canal and sew the columns of the ring and sac together, thus making a sort of plug in the inguinal canal. Other surgeons carry a ligature around the neck of the sac, tie it after having reduced the hernia, and then cut off the sac below the ligature and sew the columns of the ring together. The sac, on the other hand, may be folded up into a plug or twisted into a

rope and thrust into the canal, where it is stitched to the columns of the ring. In these operations the peritoneum lining the inner surface of the abdomen around the internal ring should be separated from the parietes for a short distance from the circular margin of the ring. This is done in order to insure solid closure of the ring by preventing the formation of a concavity at its former site, which tends to allow the pressure of the intestines to start the formation of a new hernial sac and to stretch the closed plug. In most of these operations the stump of the sac or the ring made by the old sac is supposed to be stitched behind the ring, thus making a sort of pad within the abdomen at that point.

After dealing with the sac according to any one of the methods described, the internal ring is closed by means of silk sutures carried in various ways through the abdominal aponeuroses and margins of the opening. Then the wound is closed.

In one of the operations for the radical cure of hernia the external wound, instead of being closed, is plugged with antiseptic gauze because healing by granulation is thus effected and a more solid cicatrix presumably made. This offers more resistance to protrusion of the intestinal contents than a cicatrix made when union takes place by first intention. At least such is the theory.

Excision of the sac may be employed for the cure of femoral and umbilical as well as for inguinal hernia. The borders of the ring in femoral hernia cannot, however, readily and satisfactorily be sewed together, because the margins of the ring are too rigid.

Ventral hernia occurring after laparotomy is treated by a bandage, pad, or truss; or by excision of the sac and stitching the borders of the opening together.

Radical operations for hernia, although comparatively safe when done with antiseptic precautions, are attended with a certain, though limited amount of risk, and in the majority of cases do not effect a truly radical cure. A return of the hernia is quite frequent, though the recurrent hernia may be smaller and more manageable by a truss than was the original. Radical operation is justifiable in reducible hernias which are very large and in those which a truss will not properly control.

Irreducible hernias frequently give great discomfort from their bulk or from the dyspeptic symptoms produced by their existence. In irreducible hernias the operation for radical cure is more serious than in reducible hernias, because the sac has to be opened in order to effect the reduction of the hernia. The intestinal adhesions have to be released and portions of omentum perhaps excised in order to accomplish a return of the protruded viscera. The congenital forms of hernia are more amenable to permanent cure by radical operation than other forms, but they are also more amenable to cure by truss.

Irreducible hernias often become so large that they are a burden to the patient; and they are dangerous because they are liable to inflammation, strangulation, and obstruction. An attempt should be made to protect them from injury and to prevent their increase in size by wearing a suitable bag-shaped truss or supporter. If a hernia has recently become irreducible it is proper to attempt to render it reducible. This may be accomplished by rest in bed, the administration of saline laxatives, and the application of ice to the surface of the tumor. Such measures are of no avail unless resorted to shortly after the advent of irreducibility.

Strangulated Hernia.

When a hernia becomes strangulated the reduction must be made at once, since every hour adds to the danger of the condition and increases the inflammatory changes in the gut or omentum which is subjected to pressure. Purgatives to relieve the constipation are useless and extremely harmful. Prolonged and forcible manipulation of the tumor in the hope of reducing the protruded mass is equally unjustifiable.

The word "taxis" is employed to describe the series of manipulations used in reducing a strangulated hernia.

When strangulation has occurred taxis should at once be attempted, but the surgeon must remember that the manipulations must be gentle and continued for but a few minutes. If reduction by taxis is not accomplished in this manner, the use of enemas to empty the lower bowel, and of ice locally to the tumor, and the internal administration of moderate doses of morphia may be adopted. Ether has been recommended as a local application because of its refrigerant effect. In some kinds of hernia this line of treatment will cause the tumor to become reducible, and gentle taxis employed at the expiration of three or four hours will effect reduction of the strangulated gut. A hot bath is sometimes apparently efficacious, though in strangulation of femoral hernia it appears to be valueless. If these measures fail, immediate resort to operation for the relief of the strangulation is proper.

In attempting to reduce a hernia by taxis the surgeon seizes the tumor with one hand and slightly lifts it, exerting at the same time a little pressure upon it with his fingers. The pressure on the constricted knuckle causes, if the calibre be not entirely closed by the constriction, the expulsion of gas and feces, and thereby reduces the bulk of the hernia. With the fingers of the other hand he slightly compresses the protrusion at the neck of the tumor to prevent the contents from bulging over the ring when pressure is being made with the other hand. It is often well to draw down the tumor a little with the right hand in order to pull out a little more intestine and thus disengage the protruded portion from the grasp of the ring through which it has escaped. It is clear that the portion of the hernia which has escaped from the abdomen last must be the first to be pushed back. Hence the part near the neck must be "coaxed" into the belly before the lower part can be reduced. During these manipulations the pelvis should be slightly raised. In femoral hernia the thigh should be flexed and rotated a little inward in order to relax the fascia lata which forms the external femoral or saphenous opening. The pressure exerted during taxis should be gentle and steady.

The site of the hernia causes a variation of the direction in which the pressure should be exerted, for it is easily understood that the gut must follow the same route in reduction as it took in protrusion, though in the opposite direction. Hence the line of pressure proper in an inguinal hernia is not suitable for the reduction of an umbilical or femoral hernia. In the discussion of Special Hernias the direction in which taxis should be employed in each variety will be given.

When strangulation is relieved and the hernia slips back into the abdomen, a peculiar croak is heard if there be gut in the tumor. If the reduction is not readily effected by such gentle taxis, the surgeon must desist, since force or too long employment of taxis may cause bruising of the intestine, and sometimes actual rupture. Two minutes is probably

long enough to continue the efforts in a small, tight femoral hernia, and about five minutes in other hernias, whether femoral, inguinal, or umbilical.

Taxis is more successful in relieving strangulation of recent hernias than of old hernias. It is also more effective in inguinal than in femoral hernias. Anæsthetics should always be resorted to after the first efforts at taxis have been ineffectual. It is usually best to gain the consent of the patient to operation before administering the anæsthetic so that the surgeon may proceed at once to radical measures if taxis under anæsthesia proves unavailing. If any other surgeon has previously made protracted efforts to relieve the strangulation by taxis, or the hernial tumor is tender and inflamed, it is unwise to make repeated efforts at reduction. When fecal vomiting has existed for some time and hiccough has occurred, and especially so in femoral hernia, it is not wise to make efforts at taxis. The danger in these cases lies in the fact that injurious pressure may be made upon an already inflamed and gangrenous intestine, which will be followed by rupture of the gut or fatal peritoneal inflammation. Operation is in such cases to be undertaken without running the risk of causing damage by taxis.

The operation for relief of strangulation of a hernia is called herniotomy, or kelotomy.

Herniotomy or Kelotomy.

Herniotomy is undertaken for the purpose of liberating the constricted bowel or omentum, so that the protruded structures may be returned to the abdominal cavity. If the protruded organs are gangrenous, so that their return would be followed by serious consequences, their excision, the establishment of an artificial anus, or the resection of intestine, with or without immediate suturing, is accomplished.

The incision in herniotomy is made in the long axis of the tumor, and the coverings of the hernia down to the sac are carefully divided in the same direction, or are torn apart by means of the fingers, forceps, or the handle of a scalpel. By this procedure the hernial sac is exposed. Care must be taken that the sac is identified, because if it is opened unwittingly, the intestinal wall may be mistaken for the sac and incised.

Characteristics of the sac are its tense, smooth appearance, and the longitudinal direction in which its vessels run. The bloodvessels of the intestines run around the gut in a direction transverse to its long axis. Often the sac may be picked up from the contents of the hernia in such a way that the bowel may be felt to slip away from between the fingers holding the sac. In some instances in which the sac is distended with fluid, the sac wall is so thin that the coils of intestine or omentum may be distinctly recognized within. The sac usually does not feel as thick as the intestine, when pinched between the fingers.

Under certain circumstances, it is wise to divide the stricture without opening the sac, because opening the sac is to expose the intestine to contact with air, and to invade the general peritoneal cavity, which, of course, is in direct connection with the cavity of the sac. This method of relieving a strangulated hernia is called the lesser operation for hernia, or the method of Petit. In it the neck of the sac, which has just been exposed by the incision, is thoroughly separated from its surroundings, and the surgeon's finger-nail carefully insinuated under the edge of the constricting band. This is then divided with a blunt-pointed bistoury, or hernia

knife. Sometimes the finger's tip can be insinuated under the band which strangulates, and the constriction relieved by stretching or tearing the tense tissues. If a knife is used, two or three small notches are better than one deep one, since there is then less danger of wounding the surrounding structures. Gentle efforts at taxis will then reduce the hernia, after which the edges of the hernial ring are stitched together, and an ordinary gauze dressing applied.

Herniotomy, without opening the sac, should not be performed when there is danger of the gut being in bad condition because of the length of time that strangulation has existed, nor when the hernia is known to have been previously irreducible. It is very evident that in cases where rupture of the gut from forcible taxis is suspected, that it is necessary to open the sac in order that the exact condition of affairs may be ascertained In other cases it becomes necessary to open the sac because attempts to relieve the strangulation without laying open the sac have been abortive.

When, therefore, it becomes necessary to open the sac, either because the strangulation cannot be relieved otherwise, or because the suspected condition of the hernia makes a full investigation imperative, the sac is picked up at one point with a forceps, and its wall punctured by means of a knife held horizontally. The small openiug thus made is enlarged until the whole interior of the sac is exposed to examination. It is often possible to tear through the thin sac with the finger-nail. This is safer than using a knife. Ordinarily, however, there is not much danger of injury to the gut, because in many cases there is fluid to fill the space between the intestine and the sac wall. Occasionally, however, the gut lies in immediate contact with the sac wall; then considerable care is necessary to avoid injuring it.

If the fluid within the sac is simply yellow serum, the condition of the contents of the sac may be considered good. The escape of bloody or turbid fluid, however, and especially if it exhales a fecal odor, is indicative of inflammatory and gangrenous intestine or omentum. The stricture is next sought for with the finger, and at the same time any adhesions between the intestine and omentum, or between these structures and the sac, are broken down. The finger-nail is then slipped under the strangulating band, and the blunt-pointed bistoury or hernia knife carried along the pulp of the finger until it lies beneath the constriction. The knife should be pushed under the band lying flat upon the finger. After it has been put in proper position, the edge is turned against the tight band and used so as to make two or three shallow nicks, which are better than a single deep one. After division of the stricture, taxis is undertaken.

FIG. 389.

Levis's notched hernia director.

If sufficient division of the stricture has not been performed, as indicated by the impossibility of reduction, the strangulated band should be divided or torn a little more. In those cases in which the strangulation is too tight to permit the entrance of the tip of the finger, a hernia director should be carefully inserted under the tense band. One of the best forms is the Levis notched hernia director, which catches the strangu-

lating band in a notch and holds aside the intestines, so that their injury with the knife is almost impossible.

If the intestine is found to be gangrenous, the constricting band should be notched, and nothing more done; since breaking up the adhesions is to permit access to the general abdominal cavity of the fetid fluid contents of the hernial sac. After the constriction has thus been relieved an incision should be made into the calibre of the gangrenous intestine, to permit the escape of feces. An artificial anus or fecal fistula will then be established at the site of the operation. This may be treated by operation some weeks later, when the patient has recovered from the immediate results of the strangulation.

In some cases of omental hernia, a small knuckle of gut is wrapped up or covered by the omentum. This should be sought for before the omental hernia is returned, since the whole mass may be returned with the hidden intestine still strangulated.

In many cases of operation for strangulated hernia it is difficult to decide whether the intestine is in condition to be returned. The question is easy enough of determination in cases where actual gangrene has occurred, and in instances where there is not a great deal of inflammation; but there are many border-line cases which require serious consideration. If the fluid in the sac is serous, and the intestine, though congested, still has a shiny surface, it is proper to return it. If its walls are ashy-gray in color, and show no evidence of elasticity, it is equally clear that gangrene has taken place, that the mass should not be returned, and that an artificial anus should be established. If the intestine is extensively diseased, resection of the gangrenous portion should be performed. In such an event the open ends of the bowel should be stitched to the external wound, in order that the fecal contents may escape upon the surface of the body. If the gut is purplish in color, shows ecchymotic spots, and is covered with sticky lymph, it is not always clear whether it should be returned. If a large coil presents this condition, it may be left in the hernial sac after the strangulation has been relieved, so that in the event of sloughing the extravasated feces and the contaminating fluids from the diseased structures may be kept outside of the abdominal cavity. Where a very small knuckle presents these characteristics, the surgeon may sometimes, with wisdom, push the knuckle just inside the ring, where it will probably become adherent to the belly wall. If sloughing then occurs and gives rise to perforation, the feces will have an opportunity to escape into the sac, which has been left open, without invading the general peritoneal cavity.

If by accident the intestine has become opened during the division of the coverings, the wound should be brought together by Lembert's sutures, as described in Wounds of the Intestines. Subsequently it should be returned to the abdomen as if no such accident had occurred. If the protruded omentum is small in amount, and not gangrenous, it should be returned. If, however, a large omental mass is present, or if an omental hernia of any size is thickened or inflamed, a ligature should be cast around it near the neck of the sac, the part outside of the ligature cut off, and the stump pushed back into the abdomen. A silk ligature is best and should include the entire mass in a single stump. The effort to tie individual omental vessels is injudicious.

The last step in herniotomy is the treatment of the sac. If the patient is weak, or if complications arise from the condition of the gut, or from peritoneal inflammation, the sac should be let alone and the external

wound closed with sutures or left open as previously described. If, however, these complications do not exist, the sac should be dissected away from the surrounding coverings, its neck ligated, and the body of the sac excised. This procedure is an attempt to produce a radical cure of the hernia, as by obliteration of the sac a recurrence of the protrusion may be prevented. In inguinal hernia the columns of the ring may then be sewed together with silk. In femoral hernia such drawing together of the margins of the ring is probably impossible. In umbilical hernia the sac should be cut away and the edges of the ring freshened and drawn together with sutures.

The after-treatment of cases of hernia is identical with that of other abdominal operations. Some pressure, however, should be made upon the wound by the dressing in order to prevent recurrence of the hernial protrusion.

The symptoms of strangulation usually disappear immediately after the reduction of the gut, whether it has been accomplished with or without operation.

A persistence of vomiting due to the anæsthetic may seem to indicate that the hernia has not been relieved. This vomiting, however, soon stops; it has not the gushing character of vomiting from strangulation, and is more apt to be accompanied with retching. Temporary paralysis of the muscular coat of the gut by interfering with peristalsis may simulate a condition of strangulation, while the presence of another unsuspected hernia which is strangulated may, of course, give rise to a continuation of the dangerous symptoms. Sometimes a hernia which is believed to have been reduced has simply been pushed backward in mass and lies between the transversalis fascia and peritoneum. In such instances the strangulation persists, although the tumor has disappeared from the original site, and of course the symptoms continue. Gangrene of the gut occurring after reduction may cause perforation and peritonitis. In rare instances the intestine may become strangulated within the abdomen as a result of inflammation in the neighborhood of the hernia. Acute enteritis and peritonitis, moreover, may give rise to alarming symptoms. In all such cases, if within a reasonable time, the cause of the complication is not evident, laparotomy in the median line should be performed.

It is impossible to insist too strongly upon the necessity for early interference in cases of strangulated hernia. Nearly all cases will promptly recover if strangulation is quickly relieved, while nearly all will terminate fatally if this is not effected. It is the continuation of efforts at taxis and the postponement of operation that causes the fatality in patients the subjects of this dangerous surgical disorder.

Special Hernias.

The most common sites of hernia are the inguinal canal, the femoral canal, and the umbilicus; hence, inguinal, femoral, and umbilical hernias must receive special consideration.

Inguinal Hernia.

Anatomy.—In inguinal hernia the intestine or omentum is protruded from the abdomen through the inguinal or spermatic canal. In some

cases the hernia traverses the entire length of the canal, whereas in other cases it comes through the abdominal wall directly behind the external opening; which is called, anatomically, the external inguinal or spermatic ring. In the former case the hernia is called an oblique inguinal hernia, in the latter case a direct inguinal hernia. In the first variety the neck of the hernial protrusion lies external to the deep epigastric artery, but in the second variety it is internal to that vessel. In oblique hernia, then, the intestine leaves the abdominal cavity at the internal inguinal, or spermatic, or abdominal ring, follows the canal through the abdominal wall and escapes at its lower opening, called the external inguinal, or spermatic, or abdominal, ring. Here it appears as a tumor lying outside of the aponeurosis of the external oblique muscle, just above the body of the pubic bone. If the protrusion is not large enough to follow the course of the entire canal and make its exit at the external ring, the hernia is called "incomplete," because the viscera have not completely followed the canal, but lie within it. If the hernia escapes from the external ring it is a "complete" one. As the complete hernia increases in size the intestine descends into the scrotum or vulva, and it is then denominated a "scrotal" or "labial" hernia. An incomplete hernia is often termed a bubonocele.

The coverings of a complete oblique inguinal hernia are skin, superficial fascia, inter-columnar fascia, cremasteric fascia, funnel-shaped process of the transversalis fascia (infundibuliform fascia), subperitoneal fat, and peritoneum (sac). In the female there is no cremaster fascia, and hence this covering is wanting. In incomplete oblique inguinal hernia, instead of the inter-columnar fascia, there is a covering formed by the aponeurosis of the external oblique muscle, and instead of the cremasteric fascia the lower fibres of the internal oblique and transversalis muscles make a covering. In this instance there is no difference between the male and the female. The pupil must remember that the words "abdominal," "inguinal," and "spermatic" are indiscriminately used to describe the canal and its inner and outer orifices. The different adjectives mean the same thing.

The stricture in strangulated oblique inguinal hernia occurs at either the internal or external ring, or in the canal.

Fig. 390.

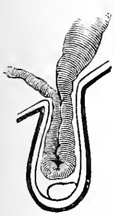


Diagram of "congenital hernia." (Bryant.)

Fig. 391.

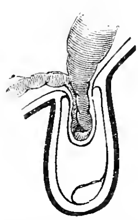


Diagram of "acquired hernia." (Bryant.)

Fig. 392.

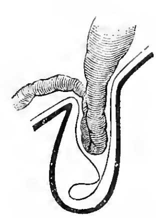


Diagram of "acquired congenital hernia," or the "encysted hernia of Cooper." (Bryant.)

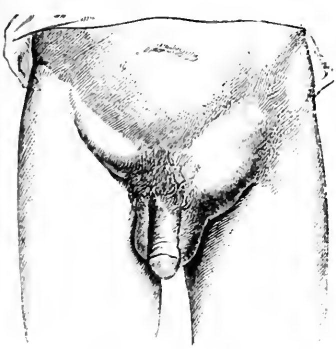
There are several varieties of oblique inguinal hernia. In the acquired form the peritoneal sac is pushed down through the inguinal canal and into the scrotum, so that the hernia usually lies above, or in front of and above, the testicle or cord.

In congenital inguinal hernia the intestine descends into the scrotum along the unobliterated funicular process of the peritoneum which makes the fœtal canal between the vaginal tunic of the testicle and the abdomen. In these instances the protruded gut lies within the vaginal tunic and comes in direct contact with the testicle. There is no true hernial sac.

In another form the hernial sac may be pushed down behind the unobliterated funicular process, and give rise to what has been termed infantile inguinal hernia. Varieties of inguinal hernia occur in which the relations of the sac and the funicular process vary from the most frequent varieties just given.

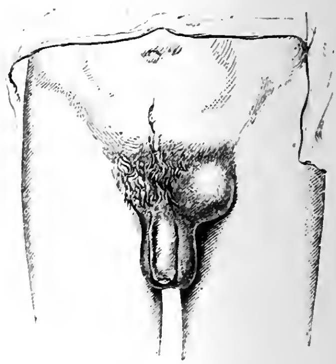
Direct inguinal hernia is a protrusion through the abdominal wall behind the external inguinal ring. In this variety the gut does not enter the canal at all, but after piercing the wall escapes through the external ring. Sometimes, however, it bursts through the belly wall a little outside of the external ring, and then does enter the lower part of the canal before emerging at the ring. The neck of the sac in both varieties of direct hernia is internal to the deep epigastric artery.

FIG. 393.



Oblique inguinal hernia. (BRYANT.)

FIG. 394.



Direct inguinal hernia. (BRYANT.)

The protruding intestine in direct hernia may push the conjoined tendon in front of it, may go through an opening in the tendon, or may pass under its lower border. The coverings of direct inguinal hernia are skin, superficial fascia, inter-columnar fascia, conjoined tendon, transversalis fascia, subperitoneal fat, and peritoneum (sac). It is evident that a covering from the conjoined tendon will not be present if the hernia, instead of stretching and pushing forward this tendon, perforates it or goes under its lower border. The strangulation of a direct inguinal hernia occurs at the external ring, or at the opening in the conjoined tendon.

DIAGNOSIS.—The differential diagnosis between oblique and direct hernia is often difficult, because when oblique hernia attains considerable size, or has existed for a long time, the internal ring is by the weight of the tumor dragged down until it is directly behind the external opening. The neck of the sac, therefore, lies immediately over the body of the pubes, and seems to be at the external inguinal ring. It is understood, of course, that a direct hernia may descend into the scrotum or labium exactly as does an oblique hernia.

Inguinal hernias present the general signs and symptoms of all hernial tumors. The neck of the sac in old oblique hernias, and in recent direct ones, as has just been stated, is over the body of the pubes and internal to the spine of the pubes. In recent oblique hernias the inguinal canal is filled up with a protrusion which can be seen and felt, occupying an oblique position above Poupart's ligament. The tumor is reducible at first, if subjected to moderate pressure applied upward and outward.

An incomplete oblique hernia might be mistaken for a femoral hernia which has curled up over Poupart's ligameut, but is differentiated by the fact that a femoral hernia has its neck below Poupart's ligament. Moreover, a femoral hernia to turn up so as to overlie Poupart's ligament must be large, and is reduced by pressure applied at first downward and backward, and then a little upward. The inguinal canal in femoral hernia is unoccupied by a mass, while in oblique inguinal hernia, even when incomplete, the mass seems to fill up or to occupy at least part of the canal.

Chronically enlarged lymphatic glands may resemble inguinal hernia, but here the tumor is apt to show the characteristic signs of enlarged or inflamed glands, and the inguinal canal is unoccupied by any swelling. The characteristic impulse of hernia is also absent.

An encysted hydrocele of the spermatic cord occupies a position similar to inguinal hernia. It is, however, tense, oval, and well-defined in outline, and without impulse. A cyst of the canal of Nuck in the female presents similar characteristics An encysted hydrocele of the spermatic cord can usually be pushed up into the belly.

An undescended testicle may be discriminated from an inguinal hernia by absence of impulse on coughing, and by the facts that the tumor is not reducible, that pressure produces the peculiar sickening testicular pain, and that the testicle on the corresponding side is absent from the scrotum. An inflamed, undescended testicle may give rise to vomiting which will suggest strangulated hernia. The vomiting, however, is not gushing, as is that which occurs as a symptom of strangulated hernia. In doubtful cases an exploratory incision is justifiable.

A scrotal hernia may be confounded with hydrocele, orchitis, solid tumor of the testicle, and varicocele. Hydrocele of the vaginal tunic is often translucent, and is a tense, semifluctuating tumor without impulse. Its rounded upper margin is generally very distinctly felt when the surgeon's fingers are placed upon the upper part of the cord and the tumor is pushed up against these fingers by pressure exerted with the other hand. This well-defined upper limit is very different from the gradual extinction of the upper portion of a hernia as it blends with or is lost in the belly wall.

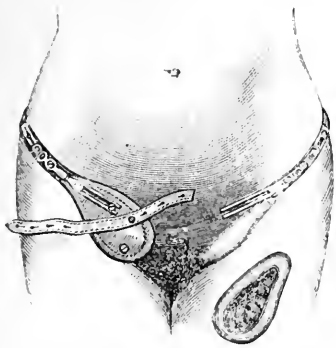
It must not be forgotten, however, that in hydrocele of infants the fluid can sometimes be pushed back into the abdomen so as to simulate hernia. There is, fortunately, no such croaking sound accompanying the disappearance of the tumor as is frequently heard in reducible hernia. Unfortunately for diagnostic purposes the hernia of children is sometimes translucent, and thus resembles hydrocele.

In orchitis the tumor is heavy, showing signs of inflammation, and is more or less ovoidal and hard. The swelling does not extend up into the inguinal canal.

Varicocele disappears when the patient lies down, is increased by pressure made upon the external inguinal ring, gives the sensation of a

bag of worms under the skin, and coughing conveys to the finger a thrill rather than an impulse. Reducible hernia is, after reduction, prevented from recurring by pressure at the external abdominal ring, and therein differs from varicocele.

Fig. 395.



Irreducible inguinal hernia showing concave moulded pad, which is already applied on right side. (Bryant.)

Treatment.—The treatment of inguinal hernia is identical with the treatment described for hernia in general. The incision should be made directly upward in order to avoid the epigastric artery, which will be upon the inner or outer side of the neck according as the hernia is oblique or direct. As it is often difficult to decide which variety of inguinal hernia exists, the position of the epigastric artery is uncertain, hence incision directly upward is safest. If an undescended testicle lies in the groin and is a complication of strangulated hernia, it may be necessary to excise the testicle at the time herniotomy is done. Indeed, such excision may be demanded in the treatment of reducible hernia accompanied by undescended testicle, in order to make it possible for the patient to endure the pressure of a truss in this region.

Femoral Hernia.

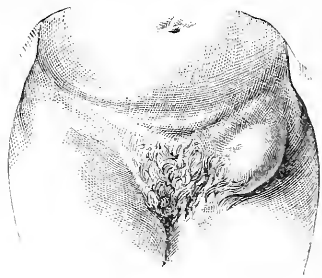
Anatomy and Pathology.—Femoral hernia is never congenital, and occurs in women more often than in men. The protruding viscera escape from the abdomen into the sheath of the femoral vessels. Usually the exit is made internally to the femoral vein through what is called the internal femoral ring. The descending intestine then follows the femoral canal and comes out upon the thigh at the saphenous opening, also called external femoral ring. If the tumor increases it turns up over the falciform process of the fascia lata and lies just below or may even overlap Poupart's ligament. In the latter case the tumor lies beneath the integument upon the aponeurosis of the external oblique muscle of the abdomen, but the neck of the sac is at the internal femoral ring. This ring or opening is situated below Poupart's ligament above the horizontal ramus of the pubic bone, where this bone is covered by the pectineus muscle. Toward the middle line the ring is bounded by the sharp edge of Gimbernat's ligament, while on the outer side it is separated from the common femoral vein by a thin, fibrous partition within the sheath of the femoral vessels. Sometimes the hernia lies in the femoral canal and does not escape at the external femoral ring or saphenous opening. It is then an incomplete femoral hernia.

There are no structures of importance on the inner and upper sides of the neck of the hernial sac.

When the obturator artery, as an anomaly, takes its origin from the deep epigastric artery, it *occasionally* curves around the inner side of the neck of the sac. It is then in danger of being wounded in the operation of herniotomy, when the stricture at the neck of the sac is divided.

The coverings of a complete femoral hernia are skin, superficial fascia, cribriform fascia, anterior layer of the sheath of the femoral vessels, femoral septum, subparietal fat, and peritoneum (sac). These coverings are often thinned so that the hernia seems to be almost directly under the skin. In other cases, however, the coverings are thickened. If the hernia is incomplete the fascia lata becomes a covering in place of the cribriform fascia. When strangulation occurs in femoral hernia the stricture is either at the saphenous opening, at Gimbernat's ligament, or at the neck of the sac.

Fig. 396.



Femoral hernia. (Bryant.)

Diagnosis.—Femoral hernia presents the ordinary symptoms of hernia. The tumor is usually small, tense, globular or ovoidal in shape, and situated below Poupart's ligament, with its long diameter transverse or oblique. The neck of the sac is felt to be external to the pubic spine, which distinguishes it from inguinal hernia, in which the neck of the sac is internal to the pubic spine. Occasionally a femoral hernia may be as large as a fist, and in such cases, as has been described, it turns upward and overlaps Poupart's ligament in a way which causes it to resemble an inguinal hernia. The essential point in the diagnosis of these large femoral hernias from inguinal hernias is the position of the neck of the hernia relative to the spine of the pubes. The neck is outside of the spine in femoral hernia. A femoral hernia never attains the immense size that is possible in inguinal hernia.

A group of enlarged lymphatic glands about the saphenous opening may resemble a femoral hernia. If a small femoral hernia is overlaid by enlarged glands the hernia may escape notice even when symptoms of strangulation are present. Suspicious symptoms occurring in such a case should cause an exploratory operation to be instituted.

A psoas abscess pointing in the groin gives rise to a swelling near to the site of femoral hernia. In such cases the tumefaction is usually outside of the femoral vessel instead of inside, as in hernia. There is some fulness in the iliac fossa, the tumor shows some fluctuation, and there is often evidence of tubercular disease in the spinal column.

Varicosity of the saphenous vein may give rise to a small tumor in the neighborhood of the saphenous opening. It presents the characteristic tortuosity of varicose veins, and will probably be associated with a varicose condition down the inner side of the thigh.

Treatment.—Reducible femoral hernias should be reduced and the recurrence of protrusion prevented by wearing a truss.

Operations for a radical cure are not likely to be successful, because the internal femoral ring has rigid borders not readily sutured with satisfactory results. In strangulated femoral hernia taxis should be undertaken with the thigh slightly flexed upon the pelvis, adducted, and rotated inward, in order to relax the falciform edge of the saphenous opening. If the tumor is large pressure should be directed downward before the hernia is pushed upward and backward. As in all hernias, lifting up the tumor so as to draw a little more intestine out through the ring is often a good preliminary manipulation. In reducing the hernia it must be recol-

lected that the portion of the gut which has protruded last must be pushed into the abdomen first.

Etherization, opium, and hot baths are not very efficacious in aiding the reduction of strangutated femoral hernia; hence, early operation is demanded in cases that do not yield to moderate taxis. The incision should be a vertical one. The skin over the hernia is usually pinched up in a fold and laid open by transfixion, because the thinness of the coverings renders an incision made by puncture from the exterior a little dangerous. The point of strangulation is discovered by the tip of the finger after opening the sac. It is usually necessary to open the sac in operations for strangulated femoral hernia, since relief of the strangulation without opening the sac is not often possible in femoral herniotomy. The strangulating band should be divided by incision inward and upward. Several shallow notches are better than one deep one, since there is less possibility of injuring an abnormal obturator artery, which might be present, curving round the neck of the sac or along the edge of Gimbernat's ligament. The occasional abnormal course of this artery renders the use of a quite dull hernia knife judicious at this stage of the operation, since the arterial wall is less liable to be injured with a dull knife than with a sharp one. The dense fibrous tissue causing the stricture is readily sawed through with a dull edge. Sometimes the surgeon can feel the artery beating as he pushes the tip of his finger against the edge of Gimbernat's ligament. Under such circumstances incision of or notching Gimbernat's ligament close to the pubic bone is less liable to do damage than the ordinary cut upward and inward. It is said that incision directly inward is not so satisfactory as one directly inward and upward, since it is apt to make a larger wound, and causes difficulty in restraining the hernia afterward by means of a truss.

Umbilical Hernia.

A hernia occurring at the navel is termed an umbilical hernia. It occurs in infants through the umbilical ring, and in adults either close to or at the opening. This form of hernia is most frequent in infants and in old, corpulent women. The hernial sac is thin and often full of holes. The contents of the sac are omentum with perhaps some coils of intestines wrapped up in it. The coverings of an umbilical hernia are skin, superficial fascia, transversalis fascia, and peritoneum (sac). Very often these coverings are so thin that there is scarcely anything outside of the hernia but the skin and the peritoneum. In adults this hernia may become very large and it is frequently more or less irreducible. Obstruction is not uncommon; strangulation is comparatively rare. In infants the condition is often cured spontaneously. Nevertheless it is wise to keep the hernia reduced by placing over the umbilicus a pad held in place by means of adhesive plaster or bandage. A large coin or a piece of cork wrapped up in an adhesive plaster with the adhesive side out may be applied with great satisfaction. The adhesive surface of the plaster keeps the coin from slipping, and a broad strip of adhesive plaster carried over the whole with the ends fixed at the back makes a convenient dressing. The plano-convex disk of yellow wax used by seamstresses for waxing thread makes a good pad and the wax adheres well to the child's skin. In adults an umbilical truss or an elastic bandage should be applied.

If strangulation occurs an incision for the relief of the stricture is

demanded. The external wound may be made over the top of the tumor, or at one side close to the neck of the sac. From the latter position the surgeon can often work under the growth and relieve the stricture with very little disturbance. It does not make very much difference in what direction the constricting band is divided, as there are no structures of importance around the umbilical aperture. An upward incision, however, is probably the most desirable. Division of the band may be made in some cases without opening the sac.

If it is necessary to open the sac great care should be taken, because the coverings are so thin that the intestine may be suddenly and unexpectedly wounded. The protruding omentum should be ligated and excised, after which the stump should be returned. Any portion of intestine hidden from view by thickened omentum should be carefully searched for, since the strangulation of gut may be unrelieved unless the intestine is fully inspected. After the strangulation has been overcome and the sac excised, the edges of the ring should be freshened and sutured with silk sutures.

In large umbilical hernias and in those giving trouble because of their irreducibility or tendency to become obstructed, radical operation is justifiable. This is scarcely judicious in small umbilical hernias, which are easily controlled by trusses.

CHAPTER XXII.

DISEASES OF THE RECTUM.

Pathology.—Certain congenital malformations of the anus and rectum require operative treatment. These congenital deformities are ordinarily discovered soon after the birth of the child, by the absence of intestinal discharge and by the occurrence of vomiting. The anus may be entirely occluded, or it may be represented by a minute orifice through which the meconium and feces are not effectually expelled. In other cases the anus may be entirely absent, and the skin between the buttocks not even dimpled in the anal region. The partition between the surface and the end of the rectal pouch varies in such cases from a quarter of an inch to an inch in thickness. If the occluding tissue is thin it may bulge down when the child cries, and transmit to the eye the dark color of the meconium on the other side; thereby indicating that it is of no considerable thickness.

In some cases the anus is perfectly formed, and it is only by the introduction of a probe, or the finger, that the nurse or the surgeon discovers that the exterior orifice has no connection with the rectum above. In still other instances, the whole rectum may be absent, and the large bowel terminate in a blind pouch at the top of the sacrum, or at a still higher point. In these cases the anus is usually imperforate, that is, absent. Clinically, it may be impossible to tell a case of simple imperforate, or absent, anus from a case of imperforate anus complicated or associated with imperforate rectum. It is readily seen that if the anus is absent the surgeon has no means of discovering whether the rectum is present or absent, unless examination of the external surface of the abdomen gives indications of a swelling due to retention of the intestinal contents in a colon which has no lower outlet.

Treatment.—The operative treatment in these cases consists in dissecting from the perineum toward the rectum, with a view of establishing an outlet for the meconium and feces. If only a thin diaphragm causes the obstruction, a crucial incision liberates the retained contents and converts the deformity into a normal condition. Operation under such circumstances is unattended with shock, and the functions are soon normally performed. If a comparatively deep dissection is required to find the lower end of the bowel, the operation is a serious one and may terminate fatally from shock. Under such circumstances, a straight incision is made from behind the scrotum to the point of the coccyx, and gradually deepened backward and upward, following the line of the coccygeal curve. Caution is required to avoid injuring the bladder. Excision of the coccyx has been advocated in order to gain room for such operative manipulation when the lower end of the rectum is situated at a high point.

Some authorities advise that when the bowel is found, an attempt should be made to draw it down and to stitch its wall to the skin. This can seldom be accomplished if the distance is great; and as it is a somewhat dangerous operative procedure under such circumstances, it is probably

best not to attempt it. If a dissection extending from an inch to an inch and one-half upward does not enable the operator to find the rectum, iliac colotomy on the left side of the abdomen is the proper operation. If it is uncertain whether the descending colon is properly developed, colotomy above the right groin is to be done.

The rectum or colon occasionally opens into the bladder, urethra, or the vagina, or upon the surface of the body, at some distance from the anal region. In such congenital deformities an attempt should be made to open the normal route to the intestines from the anal region; when this has been done successfully the abnormal opening will close spontaneously, or may be occluded by plastic operation. If it is impossible to construct a canal from the anus to the bowel when the rectum opens into the bladder, it is proper to make a perineal incision into the posterior urethra, in order to permit free escape of the intestinal contents. If the rectum opens into the vagina by a large orifice, operation may be deferred until the child is two or three years old.

After constructing new openings for the escape of feces, in cases of congenital malformation of the anus and rectum, the surgeon must use rectal bougies, or have the mother insert her finger, daily, in order to prevent cicatricial stricture.

Pruritus of the Anus.

Pathology and Symptoms.—Pruritus, or itching, of the anus is usually most troublesome at night. It may be due to lice, to the vegetable parasite causing eczema marginatum, to thread-worms, to a papular eruption about the anus, or it may be secondary to uterine disease. In some cases the gouty diathesis is probably a predisposing cause. The symptoms are violent itching, making it often impossible for the patient to abstain from scratching, while locally there is little or no cause for the troublesome affection, except perhaps a little redness of the skin. In old cases there may be enlargement of the cutaneous folds at the anal opening, and the skin is thickened and discolored by prolonged inflammation, due to scratching. Hemorrhoidal tumors may be associated with anal pruritus.

Treatment.—Anal pruritus is to be treated by removing the cause, and by keeping the bowels open, and the parts well washed. It is important that after washing, the skin should be thoroughly dried by a soft towel or absorbent cotton without rubbing the skin, since the least rubbing may start an attack of itching, which will be followed by scratching. Carbolic acid is probably the best application to relieve the intense itching. It may be used in a lotion containing from 10 to 20 grains of carbolic acid to the ounce of water, with which a little glycerin is mixed. About 5 grains of fused potassa may at times be added to the ounce of liquid with advantage. Tar ointment and sulphur ointment are also valuable. Arsenic given internally seems at times serviceable. If the disease is manifestly due to a gouty tendency, colchicum, a properly regulated diet, and exercise are important adjuvants. Relief has sometimes been obtained by introducing a conical bougie into the rectum.

Inflammation of the Rectum.

The normal pouches of the mucous membrane of the rectum sometimes become enlarged and distended, owing to protracted retention of the feces.

This condition causes pain and itching in the rectal region. There is in this disease, however, no spasm of the sphincter, such as occurs in anal fissure.

The treatment consists in drawing down the enlarged pouches with a blunt hook and clipping off the folds of mucous membrane, so that the fecal matter cannot be retained.

Inflammation of the mucous membrane of the rectum is called proctitis, and is a medical rather than a surgical condition, unless ulceration occurs. It may be due to gonorrhœa, to the use of the leaves of the poison ivy for cleansing the anus after defecation, and to foreign bodies inserted into the rectum. The symptoms are somewhat similar to dysentery. Tenesmus, rectal pain, and the discharge of bloody mucus, or of pus, are indicative of proctitis.

The treatment consists in removing the cause, and in the use of mild astringent injections, such as nitrate of silver (2 or 3 grs. to the ounce of water), or sulphate of zinc (5 grs. to the ounce), or in the introduction of suppositories of an anodyne and astringent composition.

Foreign Bodies in the Rectum.

Indigestible articles which have been swallowed may become impacted in the rectum, because their exit is prevented by the sphincter muscle. On the other hand, foreign bodies may be pushed into the rectum through the sphincter by the individual himself, as a curious sort of masturbation, or by others during the patient's unconsciousness from alcohol. Articles of extraordinary size, such as turnips, bottles, and earthen jars have thus been put in the rectum. Chronic inflammation of the rectum may be set up by foreign bodies, and, at times, simulate malignant disease of the part. Such foreign materials are to be removed by means of forceps, or the fingers, after etherization of the patient and dilatation of the sphincter muscle. In some cases, where the foreign body is large, it has been necessary to deliver it with obstetric forceps. Incision of the sphincter muscle is justifiable if sufficient dilatation to permit extraction is impossible.

Impacted Feces.

Dilatation of the rectum is not unusual in old persons; and in this pouch-like dilatation fecal masses may remain and become compressed into a large, hard mass, which it is impossible for the muscular wall of the stretched rectum to expel through the anus. The irritation from the retained fecal masses may give rise to a mucous discharge which, becoming stained with fecal matter, causes the patient to think that he is suffering from diarrhœa.

The diagnosis of impacted feces can only be made with certainty by examination with the finger introduced through the anus.

The symptoms are pain, tenesmus, and chronic constipation; this last symptom, however, is concealed in cases where the diarrhœa-like discharge, spoken of above, occurs. Laxatives and cathartics can be of no service in cases of impacted feces, because the condition is mechanical and it is impossible for the large mass to be extruded through the normal orifice; therefore, it must be broken up by means of instruments introduced through the anus. The handle of a spoon, or a pair of forceps, by which the mass may be perforated and disintegrated, is an efficient aid to the

surgeon's fingers. Repeated and copious injections of warm water and oil into the bowel will aid in softening and removing the mass thus broken into pieces.

PROLAPSE OF THE RECTUM.

PATHOLOGY AND SYMPTOMS.—By prolapse of the rectum is meant protrusion of more or less of that portion of the intestine in a healthy condition, and not the mere pushing out of the mucous membrane, which occasionally occurs in connection with hemorrhoids. The mucous membrane of the rectum is loosely attached to the muscular coat, and therefore an inch or two of the mucous membrane may project through the anus without any change of location of the rest of the bowel. This prolapse of the mucous membrane alone is called partial prolapse of the rectum; whereas the term complete prolapse is applied when the rectum is turned inside out, as it were, by a process of invagination, and all the coats form the external tumor.

Partial prolapse is, of necessity, limited in extent, because the amount of sliding between the coats is not indefinite. In complete prolapse, however, almost any length of the intestinal tube may be found external to the anus. The disease is most common in children and in aged persons, and is due to a weakened condition of all the tissues, although the exciting cause is straining. Stone in the bladder, urethral stricture, phimosis, dysentery, chronic constipation, and polypus in the rectum may be causes, because of the abdominal straining and bearing-down which they induce.

The diagnosis is very clear when complete prolapse of the rectum occurs. The smooth folds of the mucous membrane on the outside of the sausage-like tumor are characteristic. There is a groove around the mass at the site of the sphincter muscle.

Partial prolapse presents some resemblance to a mass of internal hemorrhoids, but has not the bunched appearance that is exhibited by the purplish piles and the prolapsed mucous membrane accompanying them. Rectal polypus, when protruding from the anus, is harder than prolapsed intestine, and has a distinct pedicle.

The prolapsed tissues at first appear outside the anus only after stool, but repetition of the protrusion occurs, and finally the disease may become so aggravated that the intestine is protruded outside of the body whenever the patient walks or assumes the upright position. The anus by this time has become so dilated that retention in the rectum is almost impossible. Sometimes the protruded gut becomes strangulated by the sphincter, but this is more apt to occur in the earlier than in the later stages.

TREATMENT.—The prolapsed rectum must be reduced when it first occurs by gentle, though firm, pressure with the fingers after anointing the protruded gut with some oleaginous preparation. During the reduction the patient should assume the knee-elbow position, or be placed in a recumbent position upon one side. In the case of infants it answers well to place the child upon its abdomen across the lap of the nurse. Steady pressure may be required for several minutes. It is evident that the portion of the intestine which has been protruded last must be pushed up first. If these manipulations fail, reposition may often be obtained by introducing the finger, covered with a piece of lint, into the orifice of the protruded bowel and pushing it slowly upward into the intestine. During

this manipulation the lint adheres to the mucous membrane, carrying it upward so that the invaginated bowel is drawn back into the normal position. The finger is then withdrawn, and, subsequently, the lint is pulled out.

Support to the perineum and to the rectum should be given after reduction by applying a T-bandage, which is a piece of muslin carried around the perineum and attached to a belt in front and behind. After having reduced a prolapsed rectum in an infant, I have gained support by passing a deep suture through the tissues at the verge of the anus, thus narrowing the orifice. If the prolapsed rectum is strangulated by the sphincter, it may be necessary to dilate or cut that msucle, in order to prevent the occurrence of gangrene and permit the replacement of the gut.

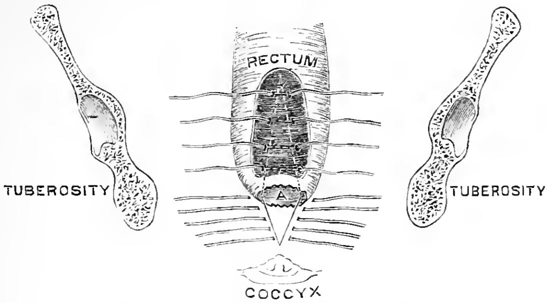
To prevent the recurrence of prolapse after reduction requires a great deal of careful treatment. The patient should never be allowed to assume the sitting position when evacuating the contents of the bowels. He should be compelled to defecate when lying down upon the side, or in a standing position. If the anus is drawn a little to one side with the fingers as the fecal material is being evacuated, the tendency to prolapse is greatly diminished. The bowels should be kept in such a condition that constipation and the evacuation of hard masses may be avoided, since all straining is dangerous. Broad strips of adhesive plaster carried across the buttocks, so as to hold the two nates close together, is quite an efficient means of giving support to the rectum in small children. Astringent ointments or suppositories, such as tannic acid (30 grains to the ounce), may be found effective; or astringent enemas containing zinc sulphate, alum, or similar preparations, or rectal injections of cold water, may be substituted for the ointments or suppositories. Glycerin suppositories will probably be found valuable in keeping the bowels open without producing straining. Under such a line of treatment cases occurring in infancy, and cases of moderate severity in adults, will probably be cured in a few months. The more inveterate cases require surgical treatment.

If there is a small mass of mucous membrane protruding from the anus, and no prolapse of the other coats of the bowel, a pair of scissors may be used to trim away the redundant tissue, in the hope that the resultant cicatricial contraction will produce cure. In more severe cases fuming nitric acid may be applied to the mucous membrane of the intestines, so as to produce sloughing and cicatricial contraction. The agent should be thoroughly applied to the entire surface of the protruded part of the intestine, excepting a circular strip extending about half an inch above the anus. Another method is clamping, with a hemorrhoid clamp, a longitudinal portion of the mucous membrane, which is subsequently cut off and the stump seared with the red-hot cautery iron. Three or four such longitudinal folds may be removed. The operation will result in cicatricial contraction of the dilated gut; and by the adhesions produced between the rectal wall and surrounding tissues the tendency to prolapse is prevented.

The orifice of the anus, which has become dilated in all chronic cases, may be reduced by cutting out a V-shaped portion of the sphincter at the posterior part or at the sides, and thus cause retention of the relaxed rectal structures. I have recently operated with satisfaction on a bad case of this affection by cutting out V-shaped portions of the sphincter and of the entire posterior wall of the rectum; the two tri-

angles having a common base at the back of the anal opening. Catgut sutures were then applied within the gut so as to bring its divided walls together and through the sphincter muscle and skin externally. This somewhat resembles the method of Dieffenbach.

Fig. 397.



Author's method of operating for prolapse of rectum.

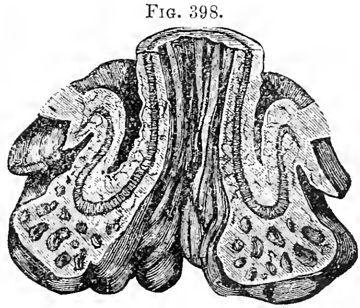
Where no operation will be permitted by the patient a certain amount of comfort may be obtained by wearing an anal truss. This consists of a belt, to which is attached a spring going between the buttocks and holding a pad against the anus.

Hemorrhoids.

Pathology.—The term hemorrhoid or pile is applied to several varieties of tumors about the verge of the anus. Unfortunately, this want of accuracy in the use of the term creates confusion in the pathology and treatment of anal conditions. It would be better if the tumors called internal hemorrhoids were the only ones to which the name hemorrhoid was applied; while to the various affections called external hemorrhoids better descriptive names might be given.

An internal hemorrhoid is a vascular tumor or angeioma, situated beneath the mucous membrane of the lower portion of the rectum, and usually not higher than one or two inches from the anus; ordinarily, these tumors lie just within the anal opening.

Fig. 398.



Internal hemorrhoids with prolapse of mucous membrane. (Treves.)

The dilated veins, capillaries, and small arteries constituting the essential structure of the pile may be held together by so much thickened connective tissue as to give the tumor quite a hardened consistence. Repeated attacks of inflammation have a tendency to increase the cellular connective tissue and to obliterate some of the vascular channels, and thereby increase the bulk and hardness of the tumor. Prolapse of the mucous membrane in the region of the hemorrhoidal tumor may also occur through

the anus and increase the bulk of the mass. The essential components of an internal pile, however, are the dilated vascular channels and the accompanying cavernous structure, which perhaps may be in part a new formation.

Anything tending to increase the blood pressure about the lower end of the rectum may cause internal hemorrhoids. Obstruction to circulation arising from disease of the heart, lungs, or liver, or from an overloaded colon, may all give rise to hemorrhoids. Downward pressure upon the pelvic contents by contraction of the diaphragm and abdominal muscles increases the congestion in the inferior hemorrhoidal vessels. It is this mechanism which gives rise to hemorrhoids in cases of enlarged prostate gland, stricture of the urethra, stone in the bladder, phimosis, carcinoma or stricture of the rectum, and in prolonged and frequent straining at stool.

Symptoms.—The presence of hemorrhoidal tumors in the rectum gives rise to pain, itching, a feeling of weight, tenesmus, and other symptoms of discomfort. Pain, in fact, may radiate to the genital organs and in other directions. At first these symptoms are not very marked, but after a time they increase, and there is a tendency for the tumors to protrude through the anus when the patient is at stool. This will require him to use his fingers to replace the growths within the rectum. Later the tendency to prolapse becomes more marked and is more constant. Finally, it is not unusual for a portion of the mucous membrane of the bowel to be prolapsed with the hemorrhoids. Such a protruding mass may, by contraction of the sphincter muscle, become strangulated, whereupon it becomes much swollen and painful, and the seat of inflammation. Occasionally gangrene of the protruding portion occurs; and if it is too large to be replaced by the patient, and he does not seek competent assistance, inflammation of the piles without strangulation may occur and cause increased rectal symptoms.

When the congestion of the growths becomes very great during straining at stool, rupture of the thinned mucous membrane covering the dilated vessels of which hemorrhoids consist may cause hemorrhage. Sometimes the bleeding is only a slight staining, at other times the fecal masses are coated with blood; while on still other occasions there may be a spurting hemorrhage of several ounces, when the patient endeavors to evacuate the contents of the bowels. This may also happen when there is no fecal mass extruded, because the desire to go to stool is felt from the swollen condition of the mucous membrane of the rectum. The blood which flows from hemorrhoids is redder than blood which has escaped, for any cause, from the bowels higher up than the rectum, since the latter is altered in character and made darker by intestinal secretions.

In long-standing disease the sphincter becomes relaxed and does not resist the pressure from above, and allows the protrusion of the piles to exist almost constantly. The bleeding often relieves the pain and other local symptoms, but if occurring frequently, as it does in extreme cases, it will lead to dangerous anæmia of the patient.

Diagnosis.—The diagnosis of hemorrhoids where they are protruding is simple enough. The difference between this disease and prolapse of the rectum has already been mentioned. When, however, the hemorrhoidal tumors are collapsed and not distended with blood, the surgeon's fingers may scarcely recognize them. A diagnosis must then be made by careful examination after the rectum has been emptied of its contents by enemas. The patient, while lying upon his side, should be ordered to bear down

as if at stool, while the surgeon draws the anus open with his fingers. If hemorrhoids exist a red or purplish shining tumor, with a more or less irregular surface, will protrude. There may be one or several such vascular masses. Between the sphincter and the tumors there is usually a deep groove. The inner surface of the protruding growth usually appears somewhat bluer than the surface near the anus. Such tumors may surround the anal opening like a rosette and at some portions show ulceration from which bloody serum escapes.

The presence of a tumor protruding from the anus and associated with great pain, because it cannot be pushed back by the patient, should cause a suspicion of hemorrhoids. Even if this pain is not accompanied with hemorrhage an ocular examination should at once be instituted.

Treatment.—I have purposely omitted the consideration of external hemorrhoids because the condition is so different from internal hemorrhoids, and I shall, therefore, at this point speak of the treatment of internal hemorrhoids alone.

Palliative treatment consists in carefully regulating the bowels, so as to keep them open, and so prevent the rectum from becoming blocked with hardened feces. Alcoholic stimulation in excess and other errors in regard to food and drink may often lead to increased discomfort to those subject to piles. Compound licorice powder, confection of senna, saline cathartics, and other laxatives answer very well for regulating the condition of the bowels. Locally the patient should use mild astringent ointments, which should be applied to the anus and pushed up into the rectum so as to come in contact with the mucous membrane. Tannic acid ointment (1 drachm to the ounce of ointment) is beneficial, and the ointment of galls combined with equal amount of the ointment of stramonium will often be found effectual. The ointment of the nitrate of mercury mixed with seven parts of simple ointment is another good application. Enemas of the tincture of the chloride of iron (ten minims to the ounce of water), and a somewhat similar enema made of the subsulphate of iron are also valuable. Suppositories of glycerin may perhaps be found convenient in keeping the bowels open; and at the same time prove a good application for the affected structures.

When the tumors are in a state of inflammation, at which time, of course, the symptoms are aggravated, an enema of five minims of the tincture of opium and half an ounce of starch-water will give great comfort, as will also the insertion of a one-grain suppository of opium. Hot water fomentations should be applied to the anus, and the patient kept in bed, with the bowels made slightly loose with laxatives. If the piles are protruded and strangulated they must, of course, be pushed back into the rectum, even if etherization and stretching of the sphincter are necessary for the accomplishment of the object.

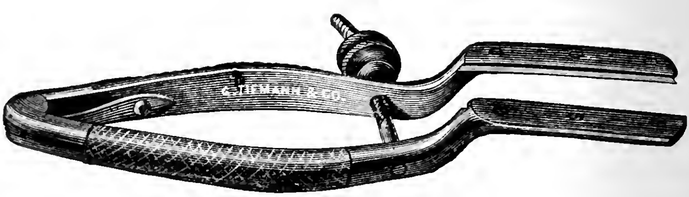
When palliative means fail to give relief, when repeated attacks have rendered the tumor so large that more or less discomfort is constantly felt, and when repeated hemorrhage shows a tendency to break down the patient's health, a radical operation is demanded. Such an operation, if properly done, causes a permanent cure. It should not be undertaken, of course, when the hemorrhoids are due to pregnancy, and perhaps not when they are secondary symptoms resulting from stricture or malignant disease of the rectum. In the last two cases the primary disease should be treated as an initial step in the management of the case.

Moderately severe cases of hemorrhoids may at times be cured by simple dilatation of the sphincter by means of the surgeon's two thumbs

inserted into the anus and then separated with as much force as he can bring to bear upon them. This operation requires the administration of ether and should be thoroughly done. It often results in such change in the circulation of the hemorrhoidal vessels as to cure the patient's disease. When the patient is not able to remain in bed for a few days for such an operation, cure may be obtained by a protracted course of treatment by means of injections of carbolic acid into the tumor. This treatment requires a long time for its accomplishment, because each individual pile must be treated separately. The length of treatment, therefore, depends upon the number of hemorrhoidal tumors, each one requiring from a week to ten days for a cure by this means. A solution of carbolic acid of the strength of about thirty grains to a fluidrachm of water, and a fluidrachm of glycerin should be used. The hemorrhoidal tumor to be operated upon is drawn down and about four minims of this carbolic solution injected into the centre of the pile by means of a hypodermic syringe. It is essential that the fluid be placed in the centre of the hemorrhoid, and not close to the surface, since in such an event it is liable to cause sloughing, with subsequent ulceration.

Of all the operations proposed for the radical cure of the more severe cases of hemorrhidal disease, the best probably is excision and cauterization. The patient's bowels should be well emptied by a laxative given the night before, and a large enema of soapsuds given a few hours before the operation. He is then placed in the lithotomy position; that is, upon his back, with his knees and hips flexed. The surgeon, as a preliminary step, should widely dilate the anus by stretching it with all his force by means of his two thumbs, which are inserted into the bowel. A portion of the large mass of hemorrhoidal tissue and prolapsed mucous membrane is then drawn down with a volsella forceps. A clamp, consisting of two blades of ivory protected by steel strips on the outer surface and

FIG. 399.



Clamp for hemorrhoids.

which can be screwed firmly together, is then placed upon the base of the pile and screwed tightly, so as to prevent hemorrhage when the tumor is cut off with a pair of scissors. The surgeon then cuts away the mass protruding from the blades of the clamp, leaving about a quarter of an inch near the clamp. This stump is left in order that there may be some tissue left to sear with the hot iron, which is now applied to prevent hemorrhage from the vascular tissues when the clamp is removed. The cautery iron should be heated to a red heat, so as to sear the tissues and occlude the open mouths of the vessels. So soon as the probability of hemorrhage is thus prevented the clamp is removed and the shortened stump allowed to recede into the rectum. The other tumors are successively treated in the same manner until all have been excised and seared. This operation removes the hemorrhoidal tissue, prevents hemorrhage, and gives

an aseptic surface which cannot readily become infected by micro-organisms in the bowels or upon the outer surface of the anus. It is thorough, efficient, and a less troublesome operation than the other usual methods.

The patient should have his bowels moved about the fourth day by means of a mild laxative, such as castor oil. Even in severe cases the patient need seldom remain in bed for more than five days, or in the house for more than ten days. Retention of urine requiring catheterization does not often occur after this operation.

Some surgeons make an incision around the internal margin of the anus and dissect out the hemorrhoidal tissue, after which the mucous membrane is stitched to the integument covering the sphincter. This operation is probably a little more difficult to perform neatly than is the operation just given, and is scarcely so sure, it seems to me, to be aseptic. If the operator has not the hemorrhoidal clamp figured in the diagram, the operation can be satisfactorily performed by the use of an ordinary pair of pincers for the clamp and a red-hot poker in place of the cautery iron or Paquelin thermo-cautery.

External Hemorrhoids.

Pathology.—The term external hemorrhoids has, unfortunately, been applied to three different conditions occurring at the verge of the anus external to the sphincter. The three forms have been called thrombotic hemorrhoids, œdematous hemorrhoids, and cutaneous hemorrhoids.

A thrombotic hemorrhoid is a blood-clot beneath the muco-cutaneous covering at the verge of the anus, due to rupture of one of the small veins, or to inflammation and thrombosis occurring in a subcutaneous vein. While straining at stool a small tumor the size of a pea may appear from rupture of a small vessel, and on examination show a purplish color through the thin skin. On the other hand, the clot may be due to inflammation of one of the veins in this locality, the inflammation being due to irritation arising secondarily from a small crack or laceration in the cutaneous tissue at the verge of the anus.

The first form, due to rupture of a small vein, may cause some little pain and soon disappear. If inflammation occurs around the blood-clot painful symptoms arise and even suppuration may occur. The symptoms then are similar to those arising from the second form of thrombotic pile, which begins as an inflammation.

The so-called œdematous pile is simply an inflammation, which may be quite severe, of the muco-cutaneous crevices and elevations which are normally present about the anus, due to the normal puckering of the skin in that region. Such inflammation gives rise to pain, a bearing-down sensation, and swelling, and is the condition usually present when one of the laity speaks of an attack of piles. The condition, of course, is simply one of inflammation of the tissue about the anus, and is in no sense related to either form of pile mentioned, except that it occupies the same locality. The term "piles," as used by the laity, is often also the condition called pruritus of the anus, either alone or associated with one of the forms of internal or external hemorrhoids.

The third condition to which the name external pile has been applied is a hypertrophy of the muco-cutaneous folds without the anus, giving rise to pedunculated tumors or tabs of muco-cutaneous and cellular tissue. The hypertrophy results from previous attacks of inflamma-

tion of these folds, such as described under the heading œdematous hemorrhoids. These enlarged cutaneous elevations give no trouble under ordinary circumstances, but when they become inflamed they cause great discomfort and symptoms similar to those produced by the thrombotic and œdematous tumors just mentioned.

TREATMENT.—It will be seen that the pathology of external hemorrhoidal tumors is quite different from the vascular condition called internal hemorrhoids, and therefore it will not surprise the reader to find that they are treated in a different manner. The thrombotic form is best managed by incising the pea-shaped tumor and scraping out the small clot, after which the anus should be bathed with an antiseptic solution and anointed with a slightly astringent ointment. The ointment of the oxide of zinc, with which 20 grains of carbolic acid to the ounce have been mixed, answers exceedingly well.

Œdematous piles are to be treated by bathing the anus with warm water, and applying a similar ointment of the oxide of zinc and carbolic acid, or one consisting of about ten grains of the yellow oxide of mercury ointment to an ounce of simple ointment. In both cases the evacuations from the bowels should be kept soft, so as to prevent pain at defecation.

The cutaneous piles should be let alone if they cause no trouble. Under other circumstances they should be cut off with a pair of scissors. They should never be ligated with a string; for while ligation is applicable to internal hemorrhoids, although inferior to excision and cauterization, it is not adapted to these cutaneous tumors. If the cutaneous hemorrhoid has a very large base, it should be trimmed off in such a manner as to leave a sort of stump, in order that the resulting cicatricial contraction about the anus may be less marked.

Cutaneous hemorrhoids frequently co-exist with internal hemorrhoids. When such a combination exists, internal hemorrhoids may be treated, and the cutaneous ones clipped away at the same operation. It must be understood that a danger after operations on internal hemorrhoids is concealed hemorrhage into the rectum, which is the reason for using the clamp and the cautery iron. In the external tumors, however, there is no special danger from hemorrhage, because they are not angeiomas; and if any occurs after excision, the external position of the bleeding point renders it amenable to treatment by means of ligation or some form of pressure. When clipping away cutaneous hemorrhoids the operation should be conducted and the wounds treated antiseptically.

RECTAL ABSCESS.

PATHOLOGY.—Abscesses may occur in the cutaneous tissue about the anus (marginal); in the ischio-rectal space, which is the fossa between the ischium and the rectal tube (ischio-rectal); in the tissue between the mucous membrane and the muscular coat of the bowel (inter-mural); and in the pelvis surrounding the rectal wall (peri-rectal). There may occur also a gangrenous cellulitis about the rectum, giving symptoms not unlike those of peri-rectal abscess.

The predisposing causes of abscess in these special locations are external injury, irritation or puncture of the rectal wall by foreign substances introduced into the rectum through the anus, inflammation due to small portions of hardened feces, or indigestible substances swallowed becoming impacted in the folds of the mucous membrane; and breaking down of

tissue from want of resistance to pyogenic infection. In all cases of acute abscess the presence of pyogenic bacteria is a necessary causative factor. Tubercular infection may cause a chronic, or so-called "cold abscess."

SYMPTOMS.—Marginal abscesses are similar to other superficial abscesses, both in symptoms and treatment. Such abscesses may be mistaken for piles unless the surgeon makes an ocular examination. The ischio-rectal abscess, which is the most common form in this region, appears as a hard mass between the anus and the tuberosity of the ischium. Aching and throbbing, with pricking sensations, are felt; the skin becomes hard, red, and brawny, and finally these symptoms are succeeded by fluctuation and evidences of pointing.

Inter-mural abscesses are usually overlooked until they burst and discharge pus into the bowel, whence it is evacuated. Peri-rectal abscesses are often similarly overlooked. The sensation of weight and fulness, and the pelvic discomfort associated with this condition, are in such cases frequently attributed to other lesions. Rigor occurring in the course of such symptoms should put the surgeon on his guard as to the possibility of suppuration taking place in this region. The finger introduced in the rectum may detect swelling, or a fluctuating tumor in cases of inter-mural or peri-rectal abscess. The latter, of course, is much more dangerous than the former, and may be secondary to malignant disease or rectal stricture. Such abscesses bursting into the peritoneum would probably lead to a fatal issue, unless the surgeon immediately opened the abdomen and washed out the pelvis.

TREATMENT.—All rectal abscesses should be opened as early as possible, and if it is thought that suppuration is about to take place, an incision, even before the formation of pus, is justifiable. In the event of pus not being given an opportunity to discharge through an opening made by operation, a great deal of burrowing usually takes place before spontaneous evacuation occurs, and, in the ischio-rectal form, an anal fistule is very apt to remain.

Inter-mural abscesses may be evacuated by tearing through the mucous membrane with the finger-nail, or by puncturing it with a knife introduced through a speculum. The ischio-rectal and the peri-rectal forms should be opened by free incision made through the skin, after which the abscess cavity should be curetted. If the curetting can be done thoroughly, the cavity may then be sewed up by deep sutures, with the hope of obtaining immediate union. If there is any doubt as to the aseptic condition of the curetted cavity, a drainage-tube had better be introduced before the wound is closed. Rectal abscess thus treated will usually recover without the formation of an anal fistule.

ANAL FISTULE.

PATHOLOGY.—An anal fistule is a communication between the surface of the buttock and the interior of the rectum by means of a narrow pus-secreting track. It results from an ischio-rectal or a peri-rectal abscess which has not been opened early enough to prevent the formation of an orifice into the bowel as well as upon the surface of the skin. After such internal orifice has been established there is difficulty in spontaneous healing of the pus-secreting tract, because small particles of feces get into the fistule from the calibre of the bowel, and because frequent movements of the sphincter muscle interfere with cicatrization.

The usual form of fistule has, as before stated, an opening upon the skin and an internal opening within the bowel. This is called complete fistule. Occasionally the fistulous track runs from the surface into the cellular tissue surrounding the rectum, but has no opening into the bowel (incomplete or blind external fistule). At other times there is an opening from the bowel leading into the abscess cavity, or suppurating tract in the tissues surrounding the rectum, but with no opening upon the skin (incomplete or blind internal fistule). These last two forms require similar treatment to the complete anal fistule, though they vary somewhat in symptoms. Incomplete external anal fistule may be due to a wound received from without. The incomplete internal fistule is hard

Fig. 400.

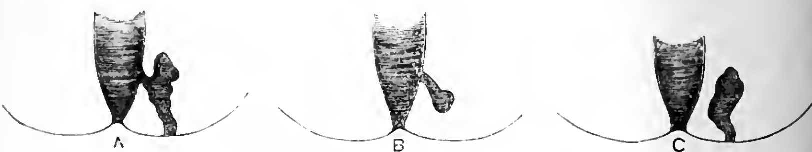


Diagram of three forms of anal fistule.
A. Complete fistule. *B.* Internal blind fistule. *C.* External blind fistule.

to recognize, because there is no external indication of the tumor, except when the cavity in the tissues around the rectum fills up with pus and makes a slight bulging of the skin. This can be made to disappear by pressing upon the cutaneous surface and forcing the accumulated pus through the internal opening into the rectum. The diagnosis in such cases may sometimes be confirmed by feeling with the finger in the rectum the ragged orifice through which the communication between the cavity and the bowel is kept up. In complete anal fistules the rectal opening is usually within an inch of the anus, but the pus-secreting pouch or pocket situated in the ischio-rectal space may extend to a higher point than this on the outside of the rectum. This is readily understood, because at the time of the formation of the abscess the pus may have burrowed upward along the rectum before the abscess pointed and finally evacuated itself into the rectum. In searching for the internal orifice of an anal fistule, the surgeon should feel with the finger, or look through the speculum on all sides of the bowel just within the internal sphincter. A probe passed into the external opening may, unless carefully manipulated, find its way into the top of the pouch alongside of the rectum, or it may readily be forced into the meshes of the normal connective tissue, instead of following the fistulous track and entering the bowel by the orifice just within the anus. The internal opening is usually single, even when the buttock is riddled by sinuses running in all directions. The internal orifice will usually be found to be the same for all these sinuses when a probe is successively passed into the various cutaneous openings. The rectal opening may be upon the side of the rectum furthest from the external or cutaneous orifice, because the pus has burrowed around the gut. It must be remembered that a sinus opening far down the thigh may, when opened up, be found to lead to the rectum. On the other hand, the surgeon should not forget that a sinus in the neighborhood of the anus may be due to caries or necrosis of the tuberosity of the ischium or of the coccyx, and have no connection whatever with the

rectum. Usually, however, sinuses in the neighborhood of the anus will be found, on careful exploration, to be anal fistules.

Symptoms.—Anal fistules, when complete, are recognized by the discharge of gas and feces through the abnormal track, and by the existence of a slight purulent or sero-purulent discharge. The external orifice will occasionally become closed and remain so for several days, perhaps for a week or two, when a slight increase of pain and some swelling will be followed by a reopening of the closed orifice, the discharge of a small amount of pus, and subsidence of the active symptoms. Quite a large abscess will sometimes form as a result of these temporary closures of the external orifice, through which drainage ordinarily takes place. A similar closure may occur in incomplete external fistules, though in these there will at no time be escape of gas or feces. Incomplete internal fistulas exhibit at times an intermittent discharge of pus into the rectum and from the anus, especially when pressure is made upon the skin, as described above.

Treatment.—Injecting the anal fistule with stimulating solutions is usually unavailing. An operation is almost always necessary for a cure. Even in cases of phthisis an operation should be performed as on a fistule in a healthy person, unless the phthisical condition is actively progressing. There is no more risk to the patient than in non-phthisical subjects. Anal fistule occurring in a patient with tuberculosis of the lungs should be treated on the same principles that would guide the surgeon in operating upon any other surgical condition in a tubercular subject. Fistule resulting from stricture or malignant disease of the rectum should not be subjected to operation, unless it is evident that the primary disease can be dealt with, or that the fistulous complication adds markedly to the patient's discomfort.

During the operation for anal fistule the patient is put in the lithotomy position, or in the elbow-knee position. The surgeon then introduces the forefinger of his left hand into the rectum, and feels for the dimple or slight elevation which indicates the internal orifice of the fistulous track. This, in most cases, is just inside the internal sphincter. A grooved director, slightly bent at the point, is then introduced into the external orifice and along the pus-secreting track until it emerges through the orifice in the rectum. Ordinarily, it is possible for the surgeon to bend the director with the finger which is in the rectum until the point of the instrument comes out at the anus. A bistoury is then carried along the groove of the director so as to divide the sphincter muscle and all other structures between the two openings. Any other communicating fistules or sinuses should then be laid open by incisions through the skin, but no second opening into the rectum should be made. After all the tracks have been thus laid open and exposed to view, it will be seen that all communicate through the various ramifications with one rectal opening. The membrane lining all these sinuses must be scraped out with a curette until healthy tissue has been reached. They should then be washed out with corrosive sublimate solution (about 1 : 2000), and the walls brought together by catgut sutures. This method converts a chronic suppurating surface into a healthy one, makes the wound aseptic, and, by division of the sphincter muscle, prevents muscular movements of the divided structures, thus giving great assistance to the healing process. An antiseptic dressing should then be applied, and movement of the bowels prevented for about a week.

The patient's intestinal canal should, however, be thoroughly emptied by laxatives and enemas before the operation.

If it happens that no internal orifice can be found when the surgeon has his finger in the rectum, and the point of the director has failed to find one, the end of that instrument may be pushed through the mucous membrane at any convenient point and the sphincter and other structures divided and treated as above. If the orifice, when found, is very high up in the intestines it may be well to cut through the sphincter and other structures with a probe-pointed bistoury or scissors, since the point of the director cannot be bent so as to protrude at the anus. Let the operator be careful not to tear up the healthy cellular tissue with a small probe point in his search for an internal orifice, but remember that in the vast majority of cases the rectal opening is not further than one inch from the anus. In internal incomplete fistule the internal orifice should be found and the tissues, including the sphincter, divided, after making an opening by forcing a grooved director or probe against the skin from within. In no case should the sphincter muscle be divided in more than one place, since such multiple division may lead to fecal incontinence. In women the division should not be made through the anterior portion of the muscle. When it is impossible to scrape out the fistulous tracts thoroughly and approximate them with sutures, it becomes necessary to plug the wound with antiseptic gauze in order to make it granulate from the bottom and prevent a recurrence of the fistule.

Recto-vesical, Recto-urethral, and Recto-vaginal Fistules.

A communication between the rectum and the bladder, the urethra, or the vagina may occur as a congenital malformation.

Such fistules, at times, result from ulceration, malignant disease, or injury. Whether congenital or acquired, the abnormal communication is recognized by the unnatural course which the feces or urine take during discharge. If the orifice is small a small portion only of these excretions will pass through the abnormal channel. If the condition is not due to malignant disease, attempts at closure should be made by cauterization with nitrate of silver, the actual cautery, or by plastic operation. Judicious cauterization and retention of the patient in such recumbent position as will prevent the urine and feces from getting into the abnormal channel will greatly aid the surgeon's efforts at occluding the abnormal fistulous aperture.

Sometimes it is well to make temporarily another abnormal opening in order to divert the urine and feces during the closure of the original defect. This opening is usually placed in such a position that it can subsequently be easily treated by the surgeon.

A speculum somewhat similar to Sims's vaginal speculum, if used in the rectum, will permit the surgeon's manipulations to be carried on with considerable ease. The plastic devices used for this condition are similar to those employed in gynecological practice, when abnormal vaginal openings are to be closed.

Anal Fissure.

Pathology.—Among the various forms of ulceration of the anus and rectum is a peculiar ulcer to which the name anal fissure is applied. It

is so different in its symptoms and treatment from the other forms of anal and rectal ulcers that it is better to discuss it separately.

Anal fissure is a local disease occurring in patients who are otherwise in good health. It is in reality either a small linear ulcer just within the verge of the anus involving the mucous membrane covering the sphincter, or a small ulcer not larger than the little finger-nail involving the mucous membrane of the rectum just above the sphincter. Such ulcers usually occur at the posterior or coccygeal portion of the anus.

A peculiarity of the condition is the intense pain that occurs immediately after defecation, and which is due to spasm of the sphincter muscle. An anal fissure frequently begins as a small crack in the mucous membrane, due to the evacuation of hardened feces causing a tear in the tissue named. This fails to heal because of the constant motion of the sphincter muscle; or possibly because a tab of hypertrophied mucous membrane or a small rectal polypus coming in contact with it prevents cicatrization. At times small and superficial eczematous ulcers may occur upon the outer aspect of the anus. These are due to a want of cleanliness, or to contact with leucorrhœal discharges. This slight condition is quite different from anal fissure, is unaccompanied by the intense pain of the latter, and is easily cured by cleanliness and the use of oxide of zinc ointment or by some similar astringent application.

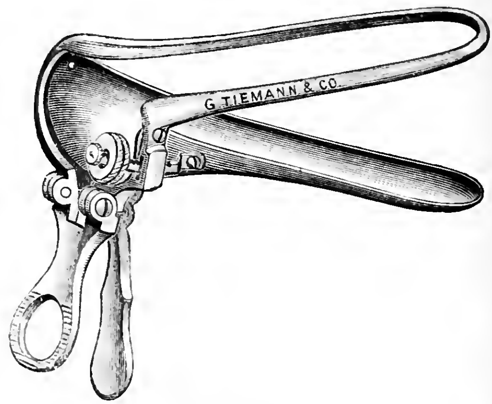
Symptoms.—The symptoms of anal fissure are remarkable, because of their severity, notwithstanding the insignificant appearance of the lesion. The pain, which is the chief symptom, is intense and smarting, and occurs immediately after defecation. This pain may last for a few minutes or it may continue for many hours. It may radiate toward the coccyx and sacrum, and finally becomes a dull ache before disappearing. There is then no return of the pain until defecation is repeated; after each stool, however, the agonizing pain occurs. Sometimes a slight discharge of a muco-purulent character or a slight bleeding may be a coincident symptom. The manner in which the pain is reflected occasionally causes the patient to attribute the suffering to disease of the bladder or the urethra. The bearing-down sensation, or tenesmus, accompanying anal fissure is sometimes remarkable. The dread of intense pain after defecation causes the patient to refrain from emptying the rectum, and chronic constipation therefore occurs as a secondary symptom. As a sequence of the difficulty in finally avoiding the hardened fecal masses so produced, greater pain and tenesmus supervene.

Spasm of the sphincter muscle is the occasion of the agonizing distress, and always exists in true anal fissure. The elevator muscles of the anus may also be involved in the spasmodic condition. In all instances of severe pain after stool anal fissure should be suspected and a thorough examination at once instituted. The irritable condition of the sphincter may result in such contraction of the anus when an examination is attempted that it will be impossible to pass the surgeon's finger into the rectum without etherization. If the presence of a fissure or linear ulcer is not discovered by examination of the external border of the anus, the patient should be etherized and the lower portion of the rectum and the interior aspect of the anus thoroughly explored by the finger and speculum. (Fig. 402.) The ulcer may be very superficial or it may be deep enough to expose the muscular fibres. As stated above it is sometimes not linear, but a small irregular ulcerated surface.

Treatment.—When the disease is of recent date cure may occasionally be effected by maintaining a softened condition of the feces by the

use of laxatives; by washing the parts after each act of defecation; and by smearing the anus and lower portion of the rectum with the ointment of oxide of zinc, or an ointment containing the red oxide of mercury (gr. 15 to the ounce). When this treatment fails, and it always will fail in the more chronic cases, operative procedures are required. The operation is so unimportant, and the relief so great and immediate, that it should not be postponed. It is ordinarily sufficient to etherize the patient and thoroughly paralyze the sphincter muscle by stretching it with the two thumbs. This dilatation should be done thoroughly and with all the power which the surgeon can exert by introducing his two thumbs and

FIG. 401.



Rectal speculum.

forcibly separating them, usually in a lateral direction. Some of the fibres of the sphincter muscle are probably ruptured by this manœuvre. Another method, which is said to be more effectual than dilatation, is to incise about one-third the thickness of the sphincter with a bistoury. The incision is always made through the base of the ulcer, beginning a little above its upper border and terminating at the muco-cutaneous junction at the exterior of the anus. A speculum is usually needed to enable the surgeon to perform this operation dextrously. One of the forms of ointment mentioned for mild cases may then be applied.

When simple dilatation of the anus has been selected as a means of cure, it is well to scrape away with the finger-nail, or with a curette, the granulations and indurated tissue forming the base of the ulcer. Any small tab of mucous membrane, polypoid growth, or small fissure complicating the condition should be excised or incised at the same time that the other operation selected is performed.

ULCERATION OF THE ANUS AND RECTUM.

PATHOLOGY.—Ulceration about the anus and rectum may be syphilitic, malignant, tuberculous, or dysenteric; or it may be due to injury from hardened feces or a syringe improperly used, or to foreign bodies. In old people there occurs an ulceration which appears to be due to chronic venous congestion, and is similar, therefore, in pathology to the senile

ulceration which occasionally shows itself in the legs. It must not be forgotten, however, that chancre may be found at the anus. The ordinary form of syphilitic ulcer belongs to the tertiary or to the congenital stage of syphilis.

SYMPTOMS.—Irregular diarrhœa, purulent discharge, pain, tenesmus, and other symptoms resembling dysentery are the clinical features of rectal ulceration. The discharges often consist of material resembling yeast, or at times coffee-grounds, mixed with more or less mucus and pus. Ulceration in the upper part of the rectum is far less painful than a small ulcer at the lower part, as has been described in another paragraph; nor does great pain accompany the latter affection when the ulceration at the lower part of the rectum is extensive. Examination with the speculum reveals the condition of the mucous membrane of the rectum; and digital examination conveys to the surgeon's fingers the sensation of rough irregularities and stiffened rectal walls quite different from health. There may be irregular distortion of the tube, and even stricture may occur.

TREATMENT.—It is essential in managing such a condition to keep the intestinal excreta soft and to use astringent and anodyne enemas and suppositories. The recumbent position may be valuable in severe cases, as it prevents abnormal congestion of the pelvic viscera. Washing out the rectum with large enemas of warm water containing boro-glyceride (1 to 30) and other non-poisonous antiseptics is a valuable means of getting rid of irritating secretions in the rectum; drying the ulcer and powdering it with a mixture of oxide of zinc (3 grs.), mild chloride of mercury (20 grs.), and powdered starch (2 drachms) is good treatment. An enema containing 10 drops of the tincture of opium to the ounce of starch-water will often relieve the distressing pain. In tuberculous ulcers iodoform in powder or suppository is indicated; 10 grains would probably be a sufficient, as well as a safe, amount in most circumstances to introduce into the rectum.

Syphilitic cases will always demand antisyphilitic remedies in addition to or instead of the tonics generally needed in ulcerations here. When great pain exists it may be necessary to stretch or divide the sphincter muscle to relieve the spasm present. In some extensive ulcerations the pain from the passage of feces over the diseased surface is so great that lumbar colotomy or excision of the lower portion of the rectum is demanded. These important operations, however, are not often required by the symptoms. Scraping away the ulcerated tissue with a curette, or cauterizing the ulcer with a red-hot iron or fuming nitric acid, is often sufficient.

STRICTURE OF THE RECTUM.

PATHOLOGY.—Malignant disease is often the cause of stricture of the rectum, but contractions of the rectum due to fibrous formations will here be alone considered. These contractions are due to chronic inflammation, or to such prolonged irritation of the muscular fibres in the rectal wall as to cause them to undergo a sort of fibroid degeneration. The coats of the rectum at the seat of coarctation are thickened or welded together either by a new fibrous tissue or an increase of the normal fibrous tissue. Ulceration of the mucous membrane is not uncommon in the vicinity of the stricture, and dilatation of the tube naturally takes place above the stricture from retention of fecal masses at that point.

The stricture when involving less than an inch of the tube is denominated an annular or ringed stricture; when a greater length of the intestine is contracted the term tubular stricture is applied. The former may be increased by further pathological changes and thereby be converted into the latter.

Inflammation and ulceration of the rectum due to operations upon this organ or other causes, as well as pelvic inflammations subsequent to labor may be the exciting cause of fibrous degeneration which results in contraction of the gut.

SYMPTOMS.—The first symptom of stricture of the rectum is difficulty in defecation, which is usually considered by the patient to be simply functional constipation. Finally the fecal masses discharged become smaller in diameter, resembling, perhaps, the size and shape of a lead pencil. At other times, however, the extruded material consists of small irregular masses, without definite shape. Occasionally they may even be ribbon-shaped. Flattened or tape-like feces, however, occur also from irritability of the sphincter without there being any stricture of the rectum. The small nodules of feces, called scybala, so usual in constipation, must not be mistaken for evidence of stricture. A bearing-down sensation and a feeling of defecation being incomplete are marked features. Diarrhœa, alternating with constipation and painful defecation, will, perhaps, supervene. When ulceration occurs as a complication of fibrous stricture, mucus and blood will probably be mingled with the feces, and the solid material passed will be small in amount and accompanied with the yeasty or coffee-ground discharges mentioned as a symptom of ulceration of the rectum. The desire to go to stool is apt to occur soon after the ingestion of food or liquid. The effort at stool is followed by little result, and is soon succeeded by a repetition of the tenesmic sensation, showing that the rectum has not been fully emptied.

Dyspeptic symptoms, such as the accumulation of flatus, become more or less prominent. Abscess or fistule in the vicinity of the stricture may cause the patient to undergo an operation for its cure without the surgeon, if he be careless, discovering that the true cause of this condition is a stricture. Retention of feces, great emaciation, excoriation of the anus due to discharges, and intestinal obstruction leading to peritonitis, and finally death, may result from long-continued fibrous stricture of the rectum.

A definite diagnosis can only be made by exploring the rectum carefully with an oiled finger. If the stricture is within three or four inches of the anus it can be felt. There is usually less than the normal contractility of the sphincter and rectum, and below the point of obstruction the rectum has a tendency to be dilated like a distended balloon. This is not due to retained feces in this part of the gut, for none are retained there. The tip of the finger may discover a sort of diaphragm in which there is a small opening, or it may feel a funnel-shaped thickening of the rectum leading up to a small orifice. The introduction of a sound with an acorn-shaped head will enable the surgeon to determine whether the contraction is annular or tubular.

If the disease is situated beyond the reach of the finger it is exceedingly difficult to make an accurate diagnosis, because the rectal bougie used for examination may become entangled in the mucous folds which line the rectum or be arrested by the promontory of the sacrum. It is possible that an examination made when the patient is standing, or makes a bearing-down effort, will bring the strictured portion within reach of

the finger. When a diagnosis of high stricture is rigidly demanded a very small hand, well oiled, may be pushed into the rectum and thrust up to the sigmoid flexure. Acute obstruction of the intestine may supervene, when the stricture of the rectum does not entirely occlude the calibre of the organ, by undigested food becoming impacted in the narrow opening. It must be remembered also that there is a phantom stricture of the rectum, as there exists a similar condition of the œsophagus, and that an enlarged prostate gland or a displaced uterus may push its wall inward and create a condition resembling stricture. A diagnosis is then made by the normal condition of the mucous membrane and by the symptoms indicative of the other pathological conditions.

Treatment.—The feces in all forms of rectal strictures should be kept in a soft condition by the use of laxatives and enemas, and an attempt be made to restore the calibre of the gut by gradual dilatation. This is undertaken by passing a well-oiled bougie through the contracted portion every other day and allowing the instrument to remain in position for a few minutes, or perhaps an hour, if pain does not contra-indicate the longer period. The bougie should be small, for no bougie that requires force should ever be passed through a stricture of the rectum. Any attempt to force a large bougie through the diseased area, or to dilate the stricture rapidly with the finger or bougie, is liable to cause inflammation or rupture of the intestine. If no pain of moment is produced by the small bougie, larger sizes may be successively substituted for the smaller instruments every four or five days. At the end of six or eight weeks a much larger bougie than that originally used will probably be comfortably received, and much relief will be given to the patient from the dilatation thus effected. It is essential that no active inflammatory conditions be induced by the dilatations. After the surgeon has given up attendance upon the case the patient should introduce the bougie for himself about twice a week. This should be continued for many months in order to prevent recurrence of the contraction. In annular stricture this method of treatment often produces cure, but it is usually of little avail in the more serious tubular strictures.

In the event of failure of gradual dilatation in the treatment of annular stricture, internal incision of the annular band may be practised, provided that the stricture is quite limited in its extent. If the stricture is extensive in area, internal incision is not free from risk, because the contact of the large wound with pus and feces, in a position where free drainage is not obtainable, is liable to give rise to serious inflammation and burrowing of pus. When, however, a small and shallow incision is made in the lesser degrees of stricture, such untoward complications are not to be expected. It therefore becomes necessary in the more extended annular strictures, and in tubular strictures, to perform linear proctotomy, which is a complete division of the rectal wall and the tissues behind it. After this operation granulation slowly closes the wound, while the calibre of the gut is maintained by the use of bougies. Linear proctotomy is performed by introducing a long curved bistoury through the anus until its point is above the stricture. The posterior rectal wall is then punctured, and the point of the knife carried backward and downward toward the end of the coccyx, until its extremity makes its appearance through the skin near the coccyx. An incision is then made which divides the stricture, the rectal wall below, and all structures between the anus and the cutaneous opening made near the coccyx. The wound is packed with

antiseptic gauze, and frequently washed out with antiseptic solutions. Bougieing should begin at the end of the first week.

Bad tubular strictures are not amenable to treatment by any of these measures, though the simple form of tubular stricture may sometimes be so treated. Temporary relief from pain and distress during defecation through the diseased gut is, however, obtainable by lumbar colotomy, which establishes an artificial anus in the left loin, and permits the extrusion of the feces at that point. This operation gives great relief, and is not as serious a procedure as would at first be supposed. It should not be delayed until the patient is exhausted by suffering.

Malignant Disease of the Anus and Rectum.

Pathology.—Cylindrical epithelioma is the form of malignant disease which nearly always occurs in the rectum and at the anus, although sarcoma and scirrhus occasionally attack this locality. The malignant affection usually assumes an infiltrated form, though occasionally the growth is a distinct tumor, projecting into the calibre of the rectum, with the mucous membrane over it remaining for a long time normal. Finally, however, the malignant tissue breaks through the mucous covering and fungation occurs. The infiltrated form begins between the mucous membrane and the muscular coat, and ulceration occurs quite early.

Symptoms.—Malignant disease of the rectum may be present for a considerable time before the symptoms are conspicuous; then pain, bleeding, muco-purulent discharge, diarrhœa, and symptoms of stricture supervene. The clinical history of malignant disease of the rectal tube is, in fact, very like that of fibrous stricture or ulceration in the same locality. When the anus alone is attacked, the symptoms are similar to rectal disease, but are more patent. A diagnosis between malignant disease and fibrous stricture of the rectum is sometimes difficult. In the former condition, however, the mucous membrane between the seat of disease and the anus is usually less ulcerated than in stricture. The course of malignant disease also is more rapid than that of stricture of a non-malignant kind.

A finger introduced into the rectum can feel the diseased area if it be not more than four inches from the anus. Ordinarily the nodular character of the rectal wall is marked, although it happens sometimes that a soft fungous mass is felt. This is the case when the disease occurs as a tumor rather than as an infiltration.

Villous tumor of the rectum, which is an innocent growth, is soft and velvety to the touch, though thoroughly resistant. In this respect it differs from the fungous form of epithelioma, which is not resistant, has a harsh feel, and is surrounded by indurated tissue. This subjacent induration is not found in villous tumor. The discharge from villous tumor is a sticky, rather clear mucoid fluid; but it is not purulent, and does not have a dark appearance like coffee-grounds. These are characteristics of the discharge in cases of rectal epithelioma.

Fistulous tracks connecting the rectum with the bladder, urethra, or vagina are not uncommon in advanced malignant disease. Pressure of the malignant growth upon the iliac veins may cause œdema of the legs. Death occurs from exhaustion or from intestinal obstruction similar to that which takes place in fibrous strictures. I have in one case known the lower portion of the rectum and the surrounding structures to be so

thoroughly destroyed by malignant disease that the space between the buttocks was converted into an immense funnel shaped opening with the apex directed upward.

Treatment.—The treatment of malignant disease of the rectum should be directed to keeping the amount of fecal matter small, and the bowels sufficiently loose to avoid impaction of fecal masses above the stricture or ulcerated surface. To this end food leaving small undigested residue and mild laxatives are to be employed. A small amount of opium is at times necessary as an anodyne. The anus should be kept free from irritation due to contact with the acrid discharges by frequent bathing and the use of oxide of zinc powder mixed with starch (twenty grains to the ounce), or by some other soothing application applied externally. Warm water enemas thrown over the seat of the disease by means of a small rectal tube, or a catheter passed beyond the malignant mass will be of service by cleansing the rectum and facilitating evacuation of fecal matter lodged above the diseased area.

These palliative measures should not be relied upon, however, when it is possible to remove the diseased tissue by excision of the rectum. This operation is easy of accomplishment in suitable cases, and gives great relief to the patient as well as prolongation of life. Excision of the rectum should not be done unless the finger introduced at the anus can reach above the malignant growth; this means that the growth must be within four inches of the anus.

Malignant disease of the posterior wall is more amenable to operation than that of the anterior or lateral walls, because of the important structures adjacent to and liable to be involved in the disease when the front of the tube is the seat of infiltration. It is possible in women, however, to separate the rectum from the vaginal mucous membrane, even when the anterior portion of the rectal tube is diseased. Operation, therefore, is more justifiable in women than in men when the morbid growth occupies an anterior situation. In a case otherwise suitable for operation it is essential that the rectum be not tied down to the surrounding structures through malignant infiltration outside the rectal wall. The general health of the patient should be in fair condition before he is subjected to the risks of operative complications. Numerous cases are upon record in which there has been no return of the disease for a number of years after excision of the lower part of the rectum.

At the time of the operation the patient, whose bowels have been previously thoroughly emptied, is put in the lithotomy position. The sphincter and skin behind it are divided by a straight incision extending backward to the coccyx. A semilunar cutaneous incision is made around each side of the anal sphincter beginning at the front of the posterior wound just made, and terminating in the perineum in front of the anus. The finger is then inserted behind the rectum and used to tear up the attachments of the rectum posteriorly and laterally. The intestine is separated from the vagina or urethra and bladder in front by careful dissection with a knife, because the finger would be liable to do damage if used for that purpose. In men it is well to place a bougie in the urethra and bladder in order that the location of these structures may be clearly perceived. After the rectum has been thus detached from the surrounding tissues to a point above the seat of disease, it is drawn down and cut across with scissors at some distance above the disease. In this manner the rectal tube and sphincter muscle are completely removed. After hemorrhage has been stopped the wound is packed with antiseptic

gauze. No attempt should be made to draw down the intestine and stitch it to the skin. Such a procedure interferes with drainage and is liable to do damage to the peritoneum above. The cavity slowly fills up with granulation tissue and a sort of pseudo mucous membrane is developed between the lower end of the intestine and the cutaneous surface. The patient regains control of the contents of the intestine in about two months. After the first two or three weeks it is well to use the bougie to prevent cicatricical contraction causing stricture.

In those cases in which excision is not justifiable, left lumbar colotomy should be done, and not delayed too long, since it adds greatly to the comfort of the patient and prolongs life even in cases of great severity.

In malignant disease of the rectum without stricture, but where there is great pain caused by passage of the feces over the ulcerated surface, left lumbar colotomy is the proper treatment.

The operation of colotomy has been discussed under Diseases of the Abdomen.

Non-malignant Rectal Tumors.

Pathology.—Fibrous and adenoid tumors having a pedicle are at times found in the rectum, and are then called rectal polypi. Fibroid rectal polypus is developed beneath the mucous membrane; while adenoid polypus originates in the mucous membrane itself, and may have a very long pedicle. Rectal polypus is a comparatively rare disease, but is more common in children than in adults. The tumor is apt to be protruded at stool, when it may be mistaken for prolapse of the rectum or for piles. The fact that hemorrhage is one of the symptoms of rectal polypus adds to the liability of the disease being mistaken for hemorrhoids. Anal fissure is occasionally complicated with small rectal polypus.

Treatment.—The sphincter muscle of the rectum should be dilated, and the polypoid tumor drawn down and twisted off with strong forceps. Twisting of the pedicle is judicious in order to avoid the possible occurrence of hemorrhage. If the tumor is sessile such removal by torsion may be impossible, in which case clamping and cauterization, as employed in removing piles, may be used. If the surgeon prefers, the tumor may be removed with scissors after transfixion of its base with needles carrying catgut or silk ligatures. The ligatures may be tied so as to cut off the blood supply before excision is attempted. Care must be observed not to divide them when cutting away the growth.

Villous tumor of the rectum is an innocent growth, adenoid in character, but has a less marked pedicle than a polypus. It does not spread and infiltrate the tissues as does malignant disease. The growth secretes a stringy mucoid discharge, and from it small fragments frequently break off and pass out at the anus. When felt with the finger it gives the impression of a soft but resistant velvety tumor, not surrounded by a hardened base as is malignant disease. It may be present for many years without causing much disturbance, except a sensation of fulness in the rectum, and occasional hemorrhage.

The proper treatment of villous disease is dilatation of the sphincter and removal of the growth by clamp and cautery, or by ligation. Curetting may be attempted, if precautions are taken to avoid subsequent hemorrhage by packing the rectum thoroughly with iodoform gauze after the operation.

CHAPTER XXIII.

DISEASES AND INJURIES OF THE URINARY ORGANS.

DISEASES AND INJURIES OF THE KIDNEY.

METHODS OF EXAMINATION.—Diagnosis of affections of the kidney is made by palpation, general symptomatology, and by examination of the renal secretion.

The general outine of an enlarged kidney can often be ascertained by pressure upon the loin by the extended hand, while the abdominal walls are relaxed and the patient lies upon the abdomen or side. Palpation may also be made through the vagina, rectum, or an exploratory incision in the loin or anterior abdominal wall.

That the product of each kidney may be separately examined, catheterization as well as compression of the ureters has been employed, but with questionable success. Where compression is made use of, the bladder is well washed out, while both ureters are compressed against the pelvis. Then one is let go, and after twenty to thirty minutes the urine which has come through it is drawn from the viscus. The bladder is now again washed, and the other ureter allowed to flow whilst its fellow is compressed.

CONGENITAL MALFORMATIONS.

Congenital malformations of the kidney, so far as surgery is concerned, consist of: Anomalies of size, blood supply, implantation of ureter, and situation in the abdomen. There may be but one kidney present, or both may be fused together (horseshoe kidney, etc.). Lobulated and multiple kidneys are unusual. Cystic disease is frequently congenital.

MISPLACEMENTS.

Misplacements of the kidney may be congenital or acquired. They are of unusual occurrence, and most common in women. One or both may be displaced; the left more frequently than the right. The amount of displacement may be inconsiderable, or such as to make diagnosis almost impossible.

The organ may be misplaced and fixed, or misplaced and yet movable; it is generally hypertrophied, but normal in structure.

Simple Misplacement.

In this variety the gland is misplaced and fixed at some anomalous point almost anywhere in the abdomen, but usually between bladder and rectum or uterus, or over the sacral promontory.

Movable and Floating Kidney.

Here the organ may be normally or abnormally situated, but is capable of making regular or more or less erratic excursive movements. Movable kidney differs from floating kidney in that the former remains behind the peritoneum, and has a more or less limited up-and-down, lateral, or rotary movement between that membrane and the spinal muscles; while the latter has pushed through the peritoneum, thereby securing a meso-nephron and an almost unlimited range of motion. In either case the renal vessels become elongated. It is frequently impossible to differentiate the two varieties.

Causes.—The causes are loose connections of capsule, injuries, traction or pressure from growths, hypertrophy or pregnancy, distention of renal pelvis, and congenital. Most cases, particularly of floating kidney, arise from the latter cause. During motion of the organ its vessels or ureter (pedicle) may become twisted, and result either in atrophy of the renal tissues or distention of the renal pelvis by urine. Floating kidney may become prolapsed into herniæ.

Symptoms.—Evidence of movement or displacement by palpation; dragging or acute pain in loin or in the displaced organ; sense of a moving body along spine or in abdomen; pain caused by certain attitudes or motions, as upon lying upon one side; increased frequency of micturition; disturbances of bladder, bowels, stomach, or mind—even hypochondriasis or insanity.

Treatment.—Corsets and imprudent exercise must be avoided. This, with perhaps the wearing of some supporting mechanical appliance or an abdominal belt, will suffice for most cases. If the inconvenience or suffering justify operation, nephrorrhaphy should next be performed. Should this fail, or, in any case, if the organ be also diseased, nephrectomy may be done after it has been ascertained that a second kidney exists. Therefore, abdominal nephrectomy will generally be more preferable than lumbar nephrectomy.

Hydro-nephrosis.

Distention of the pelvis and calices of the kidney, resulting from back pressure of urine due to partial or complete mechanical obstruction at a lower point.

The obstruction may be situated anywhere between the renal pelvis and meatus urinarius, but is usually found in the ureter, and caused by pressure from without, as by uterine fibroids, etc., also by impacted calculi and stenosis, chronically over-distended bladder, stricture of urethra, or phimosis.

One or both kidneys may be involved, depending upon the site and nature of obstruction.

The affection may be (1) congenital or (2) acquired.

1. Obstruction is likewise congenital. There is great distention—perhaps sufficient to interfere with or prevent parturition, and both sides are nearly always involved.

2. Here distention follows injuries and other acquired obstructions to the renal outlet.

Pathology.—The pelvis primarily, and calices secondarily, become distended and stretched by pressure of the retained urine. Finally, partial

or total atrophy of the renal substance ensues, the capsule becomes distended, and the whole organ becomes replaced by one large cyst. Hydronephrotic cysts vary in size from that of the normal kidney to huge proportions. The sac is very prone to form adhesions to the peritoneum and other surrounding structures. Suppuration may take place within the cyst, and give rise to pyo-nephrosis. Occasionally they rupture, discharging their contents into peri-renal tissues or peritoneum. The fluid of hydro-nephrotic cysts is urine of very low specific gravity, but may in part be made up of colloid or grumous material.

Symptoms.—The symptoms depend much upon the mode of origin. Thus, a very gradually acting cause gives rise to no symptoms until a tumor forms and signs of pressure or ulceration follow. There is always percussion dulness over an increased area in the loin; the amount of urine passed is decreased. When the disease arises from acute cause, as injury to, or torsion of, ureter, impacted calculus, etc., there at once develops great local and radiating pain and speedy formation of tumor. The swelling will be irregularly lobulated, fluctuating, flat on percussion, at first occupying the loin, later, perhaps, filling the entire abdomen. The colon is usually in front. The tumor may disappear from time to time, concomitantly with a large passage of urine of very low specific gravity, and perhaps tinged with blood, owing to temporary giving way or removal of the obstruction. This condition is termed *intermittent hydronephrosis.*

In either form, as a rule, there is little or no local or systemic disturbance, discovery of the tumor being the first evidence of trouble. Uræmia sometimes supervenes—especially when both kidneys are involved. The cyst may suppurate or rupture into the peritoneal cavity.

Diagnosis.—Vaginal and rectal examination is of greatest value. The contents of the tumor are very similar to ascitic fluid. Diagnosis from peri-renal abscess or extravasation is frequently impossible, and fortunately is of little consequence, as treatment for both is identical; careful examination will usually differentiate hydro-nephrosis from ovarian or parovarian cysts. Prognosis depends upon whether the disease exists upon one or both sides, rupture or non-rupture of the cyst, and upon the treatment employed.

Treatment.—Examine for and relieve obstruction, if possible. Accumulations of moderate size should only be interfered with when there is great suffering, inconvenience, or danger to life. Gentle massage of the tumor may displace an obstructing blood-clot, etc., from the ureter, and overcome the obstruction.

Operative treatment embraces: 1. Aspiration; 2. Incision and drainage; 3. Nephrectomy.

1. In most cases tapping is purely palliative, reaccumulation taking place in a very short time. Repeated aspirations will occasionally permanently relieve. 2. Where such reaccumulation ensues, or suppuration of the cyst takes place, the sac must be freely exposed from the loin or through the abdominal wall, incised, washed out, the edges of the cyst wound sutured to the external incision, and a large drain-tube left in. Usually, but not invariably, a permanent urinary fistula persists. Rupture of the cyst into the abdominal cavity demands immediate abdominal section, flushing out of the belly and cyst, and suture of the rent in the latter to the parietal incision. 3. Nephrectomy may be necessary when foul discharges continue for a long time to come from the sinus

remaining after incision; also for annoyances attending the presence of a persistent fistula, and in certain cases of cyst rupture.

Pyo-nephrosis.

Pyo-nephrosis is usually but a late stage of hydro-nephrosis, where suppuration within the cyst has taken place. It may also arise from cases of simple pyelitis complicated by obstruction. Acute hydro-nephrosis is especially liable to evolve into pyo-nephrosis. Repeated tappings, by infecting the cyst, frequently produce the same change; or infecting material may gain entrance through the ureter from below. Obstructive calculous disease of kidney or ureter is the almost invariable primary cause.

Symptoms.—In pyo-nephrosis there is more rapid destruction of kidney substance than in hydro-nephrosis, as well as great constitutional disturbance and severe pain, which is increased by pressure. There are fluctuations of temperature, chills, and, when chronic, hectic. Tumor usually cannot be felt. The sac is apt to form extensive adhesions, and to rupture into perinephritic tissues, peritoneum, bowels, stomach, pericardium, pleura, or upon the surface; having one or more fistulous openings. Pus may be present in the urine continuously or intermittently, if the obstruction is not absolute. Should complete destruction of the kidney take place the sac may shrink, its contents may be absorbed or caseate, and a natural, though very rare, cure result.

Treatment.—The treatment is much the same as for hydro-nephrosis. Massage should be omitted if painful, and aspiration must not be repeated if it fails once. The peripheral disease—as stone or stricture—must be removed if possible. Nephrotomy should be resorted to early, and especially if peri-nephritis exists; nephrectomy is indicated for long-continued purulent discharge or where the obstruction is irremediable and permanent.

Suppurative Nephritis.

Inflammation of the kidney which has advanced to a suppurative stage.

One or both organs may be affected, but, when both, one to a greater extent than the other. Foci or pus may develop in many portions of the kidney (miliary abscess), which later may coalesce into one or more large abscesses; or, from other causes, one or more large abscesses may originate in any part of the organ. A common cause will often originate either or both varieties. The kidney may become a mere pus sac, all renal tissue being destroyed.

Causes.—Miliary abscesses result from pyelitis, the presence of parasites, calculi, foreign bodies, decomposed clots, cancer, bladder or urethral disease, any urinary obstruction, ingestion of irritating drugs, as tupentine, carbolic acid, cantharides, etc., and as result of pyæmia and septic fevers.

Larger renal abscesses result from coalescence of smaller ones, injuries, septic emboli, metastasis from blood or lower urinary apparatus, calculi and other foreign bodies, and from continuity or contiguity of suppurative or other disease. Such abscesses may (rarely) caseate; or be absorbed or discharged into the ureter, peri-renal tissues, or elsewhere.

Symptoms.—The symptoms are generally indefinite until late. There

is sometimes great constitutional disturbance ("typhoid state"), but just as often no sign of a suppurative process. Chills, fever, and local pain or swelling, as well as the history of the case, may furnish valuable clues. Usually, no pus appears in the urine unless the abscess should rupture into the ureter.

Treatment.—The treatment must be directed to remove disease of the lower urinary tract, and to prevent continued putrefaction therein. Vigorous stimulation and supporting constitutional measures are early indicated. Quinine and laxatives should be freely exhibited. Local depletion should be reserved for acute cases. If the accumulation become diagnosable or self-evident, it should be promptly laid open, and the sac washed out, freed of foreign bodies, as calculi, if present, drained and sutured to the surface.

In doubtful cases exploratory incision down to the kidney may be employed, and an exploring needle then used to locate the pus if present.

Peri-nephritis.

Inflammation of the peri-renal cellulo-adipose tissues. Abscess is the usual result. It may occur at any age from injury, but when otherwise caused is mostly confined to adults.

Causes.—The causes may be (1) intra-, or (2) extra-renal.

1. Laceration or abscess of kidney, ulceration, pyo-nephrosis, pyelitis, tuberculosis, or calculi.

2. Here the kidney may or may not be involved. The usual extra-renal causes are: metastasis to peri-renal tissues, or involvement of them by continuity or contiguity of irritative, inflammatory or purulent processes, as from the pelvis, peritoneum, testicle, along retro-peritoneal tissues, and from the thorax; injuries, urinary infiltration, and infection after renal operations.

Pathology.—A limited portion or all of the peri-renal tissues may be involved. Or the inflammatory process may spread indefinitely to contiguous structures, or pus burrow along the fasciæ to a great extent. The kidney may remain entirely uninvolved, even after the formation of very large abscesses around it, but usually the kidney is primarily involved, and the surrounding tissues secondarily take on inflammatory action by ulcerative extension or through urinary extravasation.

Symptoms are often disguised and entirely overridden by those of the causative disease. They vary according to the acuteness or chronicity of the process. When arising from injury, hæmaturia is a frequent symptom. The "typhoid state" often supervenes in chronic or subacute cases. Pain, deeply-seated, dull, and increased by pressure or motion, exists, perhaps intermittently, in the loin. A sense of resistance and hardness is detected deep in this region. The corresponding testicle may be retracted, and bladder irritation, with increased frequency of micturition, may be present. Or all symptoms may be referred to the hip. Indeed, the contiguity of the psoas muscle to the seat of disease may readily confuse the two diseases, especially when, as occasionally happens, a peri-nephritic abscess ruptures into the sheath of that muscle and points in the groin or upon the thigh.

When abscess has formed, fluctuation may be developed in the loin, but usually not unless the collection is quite large, when a marked tumor with superficial œdema appears in the flank. If not interfered with, the

abscess will open upon the abdominal wall, through the pelvis upon the buttock, into intestines, peritoneum, vagina, bladder, rectum, lung, or psoas sheath. The contained pus is often violently offensive, but may be odorless.

Diagnosis.—Peri-nephritis must be distinguished, by the above and elsewhere noted symptoms, from rheumatism, hip, spine, or kidney disease; when upon the right side, from appendicitis and perityphlitis; from typhoid fever, impaction of feces, empyema, and pulmonary abscess.

Treatment.—Under local counter-irritation and depletion, hot fomentations and laxatives, some cases of peri-nephritis will resolve. But so soon as there is reason to suspect the presence of pus, a lumbar incision, as for nephrotomy, should be made. If pus be found, make the incision quite free, explore the cavity and surface of kidney, or its interior if opened up, with the finger, to find a stone or other foreign body if present. If a sinus only connects the kidney with the abscess, it should be thoroughly explored by a probe or finger. All sloughs are now curetted away, the cavity well washed out with antiseptic solution, and the wound sutured, leaving in a very large drain-tube. Urinary fistula does not usually form or persist.

Incision will be followed by great relief, even if made before actual pus formation. It should be free and subsequently well drained. If the source of trouble is found to be a suppurating or tuberculous kidney, the question of immediate or subsequent nephrectomy should be considered.

Tuberculosis of Kidney.

Tuberculosis of the kidney exists in two distinct varieties: 1, As part of a general miliary tuberculosis, having no surgical importance, and, 2, where the disease is localized in the kidney, or therein exists in conjunction with tuberculosis of other portions of the urinary tract.

2. In adults, but one kidney will be found involved in one-half of all cases; in children, both are affected more frequently. Persons of all ages seem equally liable to the disease. Usually, cheesy masses form in the renal papillæ, and extend deeply into the kidney substance, involving new areas in all directions. These foci may coalesce, degenerate into puriform material, and form a cold (tubercular) abscess. The kidney substance is more or less, perhaps entirely, destroyed. The ureter may become plugged with pultaceous tubercular material. A large tumor may form, but more usually enlargement cannot be made evident. When renal tissue is entirely destroyed the contents of its capsule may shrink and calcify, or in any case where the pus remains fluid or increases in amount the capsule may ulcerate and let it pass into adjacent tissues or organs, whence it subsequently makes its way to the surface. Tubercular nephritis may be complicated by the presence of renal calculi, when the disease becomes much more acute, rapid, and destructive.

Symptoms.—At first there is often unaccountable physical depression, then pain and tenderness in the loin, but the urine as yet remains unchanged. At a later period blood, but in trivial amount, pus, tubercle bacilli, and cheesy masses may appear in it, but never tube-casts. With these phenomena great irritability of the bladder with increased frequency of micturition develops, and constitutes a very significant symptom. Later still, rigors, sweats, hectic, and perhaps fluctuating tumor in the loin appear, or, in lieu of the latter, the quantity of pus in the urine may

greatly increase. On the other hand, any, or almost all, symptoms may be absent in not a few cases.

This disorder is most liable to be confounded with renal calculus, but may usually be differentiated therefrom by the degree of constitutional involvement in tuberculosis, and by the absence of bacilli and much greater amount of blood in calculus. Inflammation of the lower urinary tract is common in the former disease, rare in the latter.

If tuberculosis attacks both kidneys or affects a wide expanse of the urinary tract, death usually ensues in from a few months to several years. If one gland alone be affected, cure may result spontaneously or through surgical aid. General miliary tuberculosis may occur.

Treatment.—The general condition of the patient should receive treatment appropriate to tuberculosis elsewhere. Locally, nephrotomy and drainage or antiseptic packing should be employed. When early undertaken, this method is satisfactory in result, but when operation is performed after general destruction of the organ or formation of perinephritic abscess, nephrectomy is more advisable if the other kidney and the lower urinary organs are not similarly affected.

Renal Calculi.

Renal calculi may form at any age, but are not frequent before the fifteenth and after the fiftieth year. They may be congenital, present in one or both kidneys, single or multiple. They vary in size from a few grains to several ounces in weight, and in shape from round, or round with facets where they touch one another, to an exact cast of the pelvis and calices of the organ.

Causes.—The causes are generally constitutional: those predisposing to deposit of uric acid or to decomposition of the urine. But inflammatory disorders of any portion of the urinary apparatus with decomposition of urine may, by extension to, or irritation of, the kidney, give origin to them. Foreign substances, as blood-clots, tumors, etc., in the gland may likewise cause deposition of urine salts and the formation of a calculus. When arising from constitutional cause, both kidneys are commonly involved, but when from local causes the disease is usually unilateral. Stones located in the tubular substance give rise to severe symptoms even when of minute size, while those situated in the renal pelvis or calices may be large, and exist for a long time without causing definite symptoms or being suspected.

Usually the nuclei of renal calculi are formed by salts precipitated from the urine in retention cysts, or by decomposition transmitted to the pelvis of the gland through the ureter. These become plastered together by mucus, blood, etc., and upon the nidus thus formed are deposited layer after layer of uric acid or salts, until a calculus of varying size is produced. Stones may arise in any portion of the kidney, but always produce more or less nephritis or pyelitis, according to their situation. Abscess may originate around them. Those which develop in the renal substance form a bed for themselves by pressure absorption, and are apt to ulcerate into the pelvis or a calyx. Rarely they make their way through the capsule, escape into the surrounding tissues, and cause perinephritic abscess. By dropping into the ureter they may pass into the bladder or become lodged in that canal, and give rise to urinary obstruction with acute hydro-nephrosis and "renal colic." Should both ureters become

obstructed, death may ensue from uræmia. From the bladder they may pass *per urethram*, or remain and give rise to vesical calculus. Finally, a stone may become completely encysted in the kidney and give rise to no further annoyance.

SYMPTOMS.—If no symptoms are present the case has not yet become surgical. But if signs are present they usually comprise continuous or intermittent dull or agonizing pain in the loin, with retraction of the corresponding testicle, and perhaps referred pains in the penile head or shooting down the thighs. Or pain may be dull with acute exacerbations.

There is vesical irritation, increased frequency of micturition, and perhaps spasm; continuous or intermittent hæmaturia, even pus in the urine in acute cases or where renal suppuration or pyelitis has been set up. Albumin may likewise be present intermittingly or continuously either from kidney irritation or consecutive—perhaps chronic—nephritis. The posture of the patient is such as to relax and ease the affected side and to prevent jarring or motion. Exercise, carriage or horseback riding cannot be tolerated, or may precipitate an attack of renal colic. Pain is increased also by pressure. Rarely very large stones can be palpated, or, where there are several, may be felt to grate upon each other. Sympathetic pain in the opposite kidney may simulate the presence of stone there also, but other symptoms will be absent.

Constitutional symptoms of grave character may develop from kidney changes incident to the presence of calculi. A history of former attacks or of having passed uric acid or minute concretions is of great diagnostic value.

TREATMENT.—When it is known or strongly suspected that renal calculus is present, and the symptoms are distressing or urgent and demand more than tentative treatment, the operation of nephro-lithotomy should be performed. Even should operation be undertaken and no calculus discovered, symptoms are invariably more or less relieved thereby, and there are few risks involved. Moreover, diagnosis is thus established. Where calculus is complicated with hydro- or pyo-nephrosis, etc., the indications are, if possible, even more strongly in favor of operation. Nephrectomy may be found necessary to permanently relieve certain complicated cases.

Renal Colic.

Renal colic occurs when a calculus enters the ureter. Its onset is generally very sudden and unexpected, and apt to set in after exertion, coughing, straining, etc., have displaced a calculus from its renal bed. Pain is most intense, often causing nausea, vomiting, fainting, or collapse. It darts down the lumbar plexus into the testicle, penis, and thigh. Chill or convulsions may follow. There is great vesical irritability, tenesmus, and desire to micturate frequently. The urine is blood-tinged, diminished in quantity, and loaded with urates. Copious perspirations take place. These symptoms continue unabated or intermittently, while muscular action and urine pressure force the stone along the ureter and finally into the bladder, when they cease like magic. From a few moments to as many days may be consumed in the making of this transit. Successive stones may follow the first at varying intervals.

TREATMENT.—Anodynes to control or palliate pain, and even an anæsthetic for the more severe paroxysms, should be freely administered.

Local or general application of moist heat is very grateful. If symptoms persist unduly the ureter must be cut down upon and the stone extracted. The latter is especially indicated where uræmic symptoms ensue from obstruction of one or both ureters.

Renal Fistulæ.

Renal fistulæ are passages other than its normal outlet connecting the kidney with the skin surface or other organs. These usually are caused by ulcerative, suppurative, or obstructive disease, and as a result of accidental or surgical wounds of the organ.

The sinuses may communicate with the rectum, small intestine, stomach, vagina, or open upon the groin, thigh, etc., and may themselves become blocked by concretions and originate obstructive symptoms. Pus usually accompanies the urinary discharge. The entire secretion of a kidney, or but a very small proportion, may thus escape.

Treatment.—The cause which has given rise to the fistula should be removed if possible, communication with the kidney made evident, and a long time allowed for the tract to close spontaneously, if it will, before other treatment is undertaken. If no success results from these methods, stimulating injections, applications of the cautery, or laying open the sinus may be tried. These also failing, and the patient's condition demanding, nephrectomy should be done.

Tumors of the Kidney.

These may be (1) solid or (2) cystic.

1. The solid tumors which affect the kidney are: sarcoma, carcinoma, papilloma, lipoma, and rhabdo-myoma. Carcinoma is most usually metastatic. All are prone to degenerations. They occur with equal frequency in either sex and at all ages. Both kidneys are not uncommonly conjointly or consecutively involved. Renal tumors mostly originate in the peripheral cortex and spread inwardly. There is little tendency to involve neighboring structures, or to spread along lymphatics, unless it be during advanced stages, but great size is frequently attained.

Symptoms.—The symptoms are generally obscure until enlargement of the organ can be made out. Cachexia and great loss of weight indicate a malignant tumor. Pain—perhaps referred to distant points—may or may not be present. In sarcoma, carcinoma, or papilloma the urine may contain blood or bits of the growth which may be recognized microscopically. Fever is generally absent. Varicocele and other pressure symptoms are often very marked.

Diagnosis.—The diagnosis at any stage of development is often impossible without exploratory operation. Growths are diagnosed from inflammatory enlargements, by absence of fever, also of severe pain, as a rule. Renal tumors do not project backward, the colon is always in front; there is no line of percussion resonance between the growth and spinal column, and it is usually of symmetrical rounded proportions.

Treatment.—Benign growths, when recognizable, require no treatment except for pressure symptoms or inconvenience occasioned by their size, when nephrectomy may be considered. When malignant tumors are diagnosed and there is fair reason to believe that they are of

primary origin, limited to one kidney, and other structures have not become likewise diseased, nephrectomy should be attempted.

2. Cystic tumors of the kidney other than have already been considered, embrace: simple obstruction or conglomerate cysts—usually limited to one kidney; congenital cystic disease, which is always bilateral, may develop to enormous size before birth, in infancy, or even late in life, and in which condition one renal gland is unable to supplement or assume the work of its fellow; and echinococci, or hydatid cysts. The latter are rare, usually involve the left kidney, behave in a manner almost precisely similar to hydro-nephrosis; may attain huge size, entirely destroy the kidney and rupture or suppurate into contiguous tissues or organs.

Treatment.—All cysts, when large or inconvenient, should be treated by incision and drainage (nephrotomy) through the loin or any prominent fluctuating point. This measure failing, nephrectomy may be employed in all except those arising from congenital cystic disease, as in the latter the affection is invariably bilateral, and nephrectomy will certainly cause death from uremia.

Injuries of the Kidney.

Slight contusions, with or without hæmaturia and swelling in loin, may give rise to nephritis (traumatic nephritis). More severe contusions may give rise to laceration of kidney substance or rupture of the organ. Such injuries are attended by great shock, hæmaturia, or even severe or fatal hemorrhage through the ureter, and perhaps effusion of blood and urine into the peri-renal tissues or peritoneum. Peri-nephritic abscess, pyæmia, suppression of urine, and uræmia, also bladder trouble from putrefaction of clots remaining in it, may subsequently ensue. Or the ureter may become choked with clots, cause obstruction, and thus facilitate even greater extravasation of urine; or it may become obstructed permanently by contraction of cicatrices or adhesions.

Treatment.—Ordinarily rest, anodynes, and an ice-bag to the affected loin are all that will be required primarily. Symptoms of inflammation call for local depletion or counter-irritation and warm poultices or fomentations. Hemorrhage may in addition be treated by pressure, as with a tight abdominal binder. Peri-renal abscess or extravasation should be treated by incision. Rupture into the peritoneal cavity must be treated by immediate abdominal section and perhaps nephrectomy.

Open Wounds of the Kidney.

Open wounds of the kidney are usually inflicted by knives, bullets, or splinters. When entering from behind, the peritoneum may escape injury, but when the direction of the vulnerating force is from the front, almost invariably that membrane is injured. The kidney may prolapse through an extensive wound.

Symptoms.—The symptoms of this class of injuries are mainly those described under Contusions. Urine and hemorrhage may come from the wound. Shock is severe. Peritonitis soon arises if the abdominal cavity is involved. Suppurative processes in the kidney are apt to follow.

Treatment.—The wound should be enlarged, explored and cleansed. Hemorrhage is best controlled by packing-in gauze strips. If bleeding does not persist, suture the wound, leaving in a large drain-tube and dress antiseptically. If the kidney is hopelessly crushed or hemorrhage

cannot be controlled, nephrectomy must be resorted to at once. If the peritoneum is involved, abdominal section, followed by thorough cleansing of the abdomen and the leaving in of a drain-tube to the seat of injury should be performed without delay. When the kidney is prolapsed through a wound, but not badly injured, it may be cleansed, returned to proper position and there retained by sutures or packing; but if much injured it should be cut from its pedicle after thorough deligation and removed.

Operations upon the Kidney.

Aspiration.

Aspiration or tapping of the kidney should be performed under rigorous antiseptic precautions. The aspirating needle should be inserted into any prominent fluctuating portion of the tumor, but if such does not exist the kidney may be entered by introducing the instrument in a forward and inward direction at a point two and a half inches posterior to the center of a vertical line drawn from the last rib to the anterior superior iliac spine.

Nephrorrhaphy.

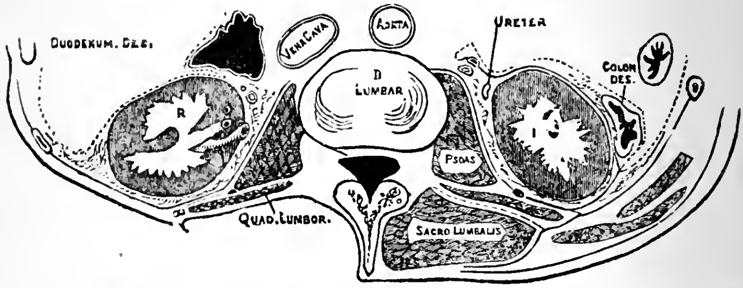
Nephrorrhaphy is the operation of suturing a movable kidney to the posterior abdominal wall. The bowels having been well emptied by laxatives and enemata, the patient is placed upon his unaffected side with a pillow or padded block beneath the loin, that the opposite flank may be made prominent and the space between the ribs and ilium made as great as possible. The affected kidney must also be steadied by pressure upon the anterior abdominal wall. The twelfth rib is now located by counting from above downwards, and a four and a half inch incision is made parallel with it, but three-quarters of an inch lower, and carefully deepened until the fatty renal capsule is well exposed. If the anterior border of the quadratus lumborum muscle is in the way it should be freely divided. Excessive hemorrhage can be controlled by temporary firm packing with hot sponges or gauze. The capsule is now well drawn out and sutured by from eight to twelve strong chromicized catgut sutures to the deepest portion of the wound. The wound is now closed by deep sutures, several of which should also pass through the fibrous capsule or even tubular substance of the kidney. A large drain-tube should be left in, or if there is continued hemorrhage the wound should be packed and allowed to heal by cicatrization, thereby securing an even stronger anchorage. Recumbent posture must be maintained for five or six weeks, until all adhesions have become firm and strong, and a well-fitting abdominal belt worn for a year or two following.

Nephrotomy.

Incision into any portion of a kidney. Incision is made as in nephrorrhaphy until peri-renal fat, tumor, cyst, or abscess is met with. The fatty capsule is torn through between forceps, or the cyst or abscess cut into at once. Bleeding must be controlled by temporary packing or ligatures as the operation proceeds. After the kidney has been well exposed, and palpated or explored by needle, it is cut into, if necessary, in a longitudinal direction in the plane of the uriniferous tubules

with a narrow-bladed scalpel. If the disease is found to be limited to the renal pelvis that portion only should be divided. A finger is then introduced into the renal substance or pelvis and exploration made. Even if no disease be found, simple incision into the kidney is usually followed by disappearance of all pain and former symptoms. Wounds of the renal tissue often bleed fiercely, but bleeding is easily controllable and soon ceases when packing is resorted to. When large cysts are incised

Fig. 402.



Horizontal section of body between second and third lumbar vertebræ looking upward. Right side of subject is at the reader's left hand. Relation of kidneys to peritoneum and muscles is shown. Peritoneum indicated by dotted line. (Lange.)

their walls should be sutured to the parietal wound, which should in turn be drained and deeply sutured or packed and allowed to granulate. The tube should go to or even into the renal incision. Secondary hemorrhage must be treated by packing, ligature or cautery. After kidney incision urine may discharge from the external wound for several weeks, or a permanent fistula may form, but is unusual in absence of urinary obstruction.

Nephro-lithotomy.

Incision into and removal of a calculus from the kidney. The procedure is almost identical with nephrotomy. When the kidney has been well exposed, as above, it is carefully palpated by carrying the index-finger over it systematically in all directions. This failing to locate the stone, an exploring needle may be inserted in various directions. A calcareous vessel may impart the sensation of having struck a calculus. When the stone is located, incision is made directly down upon it as nearly as possible in the plane of the tubules, and it is removed by the finger or forceps. But if no stone can by the above means be located, the kidney may be incised, and an exploring finger introduced. When one calculus has been removed search should be made for others which may be present.

Nephrectomy.

Removal of a kidney. The kidney may be excised without interfering with the peritoneum, by the (1) lumbar or posterior method, or by the (2) abdominal or anterior method through the peritoneum. Both procedures have marked advantages and distinct fields in certain cases.

1. This method affords the advantage of non-interference with peritoneum and excellent drainage, but is attended by the great disadvantage

of having often to ligate the pedicle at great depth, and not being able to ascertain the condition of the opposite kidney. The principal accidents to be feared are: tearing of the peritoneum, colon, or vessels of the pedicle, or opening up the pleural cavity by a too extensive or too high incision.

It is particularly adapted for small solid or cystic tumors, inflammatory disease, or where operation is undertaken to relieve urinary fistulæ, or by those unfamiliar with abdominal surgery.

2. This method permits examination of the opposite kidney, gives room to deal with and permits easy extraction of large growths, for which, and floating kidney, it is chiefly indicated. In the hands of those skilled in abdominal work this procedure may the more frequently, and for other conditions, be employed.

Lumbar Nephrectomy.—Incision is made and the kidney exposed as in nephrotomy. If then more room is required, a second incision may be carried vertically downward as far as may be necessary from a point about one inch anterior to the posterior extremity of the primary wound. The organ is then rapidly shelled from its fatty bed, and the pedicle, consisting of vessels and ureter, isolated. This is most easy where adhesions do not exist. Otherwise they must be carefully separated by the fingers. If adhesions are very strong, the kidney capsule must be incised from end to end, and the renal substance shelled out in the form of tumor and pedicle.

The organ is next brought into the wound, or out of it, but using only the slightest traction upon the pedicle. The latter is now isolated by transfixion with an aneurism needle armed with a double extra strong silk ligature into two portions—one consisting of the bloodvessels, the other of the ureter—and each is separately ligated. A third ligature is now thrown around the entire stump at a more peripheral point and firmly tied.

The pedicle is then grasped by forceps and the kidney cut away considerably above the ligatures. If the ureter is healthy, it may be dropped into the wound with the pedicle; otherwise it should be isolated and sutured to the skin margin. If the growth be very large, it may sometimes be found preferable to place a snood or rope écraseur about the pedicle and cut away the tumor before ligation is done. No considerable traction must ever be placed upon the pedicle, as it is apt to be very friable, and when torn gives rise to terrific hemorrhage. The wound should be closed and dressed as in nephrotomy.

Abdominal Nephrectomy.—Abdominal section is made, as a rule, through the linea semi-lunaris of the affected side. Its situation and extent will depend upon the size and location of the kidney, but usually its centre will be upon a level with the umbilicus. In certain unusual cases median incision will prove more advantageous. The presence and condition of the opposite kidney is then ascertained by a finger introduced through the wound. If that organ is absent or also palpably diseased, nephrectomy should be abandoned and the wound closed. Otherwise the colon, which usually presents in the wound, is pushed outward and back toward the spine, and the posterior layer of the meso-colon is exposed covering the kidney. While intestines are kept away with large retractors or flat sponges, the meso-colon is incised vertically four inches.

If the tumor be cystic, it is now tapped with a large trocar and its contents withdrawn. Otherwise the meso-colon incision is extended sufficiently to permit delivery of the growth. Two fingers or the hand are

now introduced, the kidney shelled from its bed, and a pedicle isolated. The tumor is now raised up or delivered without traction upon the pedicle, and the latter is ligated as in the lumbar method. If the ureter is extensively diseased, it should be isolated and sutured in the abdominal wound or brought out through a counter-opening in the loin made by thrusting the knife from within outward. Drainage may be secured by the usual glass abdominal drain, or by a tube through the counter-opening. Where the latter is employed, the meso-colon wound should be sutured, if possible.

The Ureter.

This canal is liable to obstruction, and to become affected by extension of disease from the kidney above or bladder below. It is but very rarely primarily involved by disease. Obstruction of the ureter, as by a descending calculus, usually gives rise to obstructive symptoms, renal colic, or kidney disease. Injuries may give rise to extravasation of urine or result in cicatricial obstruction. Obstruction from impacted calculus may occasionally demand abdominal section and removal of the stone. Nephrectomy of the corresponding kidney may be called for by the same, or when the ureter has been ruptured or divided, as by a stab or gunshot wound.

Catheterization of the ureters has for its object to ascertain whether the canal is pervious or to find out the condition of the urinary secretion coming from each kidney. The operation is only possible of application in the female. The urethra is dilated, a finger inserted, and a ureteral orifice located. A special catheter is then passed along the inserted finger as a guide and into the ureter. When a sufficient amount of urine has been secured the instrument is withdrawn, cleansed, and then introduced likewise into the other ureter. Attempts to locate the ureteral outlets, and into them insert the catheter by the guidance of a finger in the vagina, usually fail.

The Bladder.

Methods of Examination.—The usual method of exploring the bladder is by means of solid metal sounds, through which are conveyed to the educated hand a more or less accurate idea of the condition and solid contents of the viscus. To the instrument can be attached a sounding board which will amplify sounds elicited from contact with foreign bodies or calculi for class demonstration.

Digital examination through the vagina, rectum, or bimanual exploration—a finger in the rectum or vagina, and a hand upon the abdominal wall—are all useful methods, but must be gently performed, especially in the presence of calculi or foreign bodies.

But best and most accurate of all methods is the electric cystoscope of Nitze and Leiter, which affords a visual examination of the entire bladder wall and its contents. The male bladder may also be explored by means of perineal or supra-pubic cystotomy; the female bladder by dilatation of the urethra and digital examination.

Congenital Malformations.

Congenital malformations are unusual. There are several varieties, such as entire absence, multiple, or two-lobed bladder with a septum

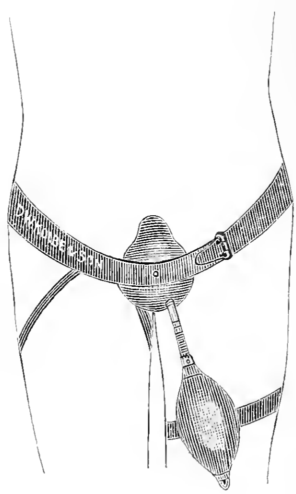
between and a ureter emptying into each division, exstrophy, and pervious or patent urachus.

Exstrophy.

A congenital condition wherein proper development of the alantois is interfered with during intra-uterine life, and results in failure of the anterior walls of the abdomen and bladder to unite in the median line. Possibly, portions of the abdominal or bladder wall may be absent. The defect is invariably associated with absence of the symphysis pubis, and in the male with complete epispadius. Males are more frequently affected than females, in the proportion of ten to one. This condition, with its associated deformities, is the one which most commonly gives rise to instances of mistaken sex and to cases of so-called hermaphrodism.

Symptoms.—At the site of non-union of the lower abdominal wall a glossy red vascular prominence presents, terminating below in the groove of a deformed or split penis, or, in the female, in a divided clitoris and labium minor on each side. Above, the prominence usually terminates at the site of the umbilicus, which is absent. The recti muscles are greatly separated clear to their ensiform insertion. The symphysis pubis is absent, but the ends of the pubic bones project or can be felt about two to four inches separated on each side, and are connected beneath the urethra by a tough ligament made up of the hypertrophied sub-urethral fibres of the triangular ligament. The penis is flattened or split, complete epispadius exists, and the scrotum may likewise be divided or absent.

Fig. 403.



Urinal for exstrophy.

The testicles are usually in the scrotum, but may remain in the abdomen or inguinal canal. Herniæ frequently co-exist.

There is spreading of the pelvis, consequent separation of the thighs, and a characteristic waddling gait from this cause, and from bending forward to prevent friction upon the exposed posterior bladder wall. This latter is usually covered with sensitive granulations, which bleed upon slightest contact. The ureteric orifices are plainly visible, and perhaps surrounded by masses of granulations. From them urine flows in intermittent jets. Intra-abdominal pressure, as from standing, straining, etc., makes the protruding mass much more prominent. Distressing eczema of the surrounding tissues results from continual contact of urine.

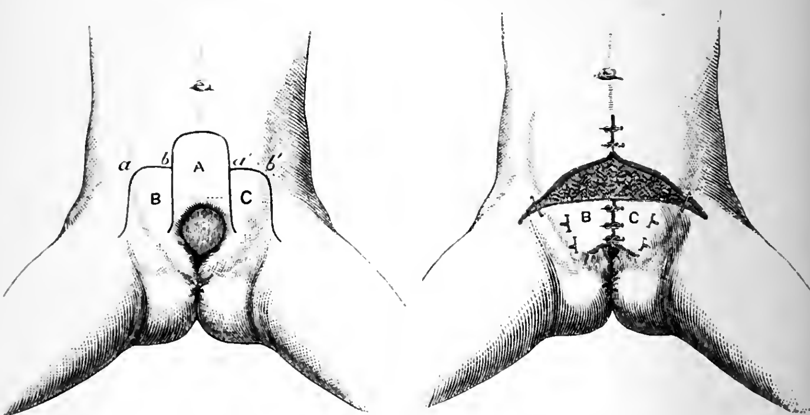
Treatment at very best can be but palliative, and is often futile. India-rubber urinals of special design may be worn by adults to protect the surfaces and collect the urine, but cannot be applied to children, and are never fully satisfactory. An attempt should be made in certain cases to partially or wholly cover-in the exposed surfaces by a plastic operation. The male genital organs when involved cannot be rendered potent.

There is usually present everything to make an operation difficult and unsuccessful: the abdominal walls are very thin, herniæ may exist on

each side, the health is run down, great eczema is present, and asepsis cannot be maintained.

OPERATION.—All hair upon the proposed flaps having been previously destroyed by depilation or nitric acid, the parts and surroundings are made surgically clean. Three flaps are now outlined. A large one is dissected from above the exposed mucous membrane, and a smaller one from each groin. The upper flap is now turned, skin surface down, over the bladder, and its upper angles sutured with wire to the lower

FIG. 404. FIG. 405.



Operation for exstrophy of bladder. (ASHHURST.)

corresponding angles of the groin flaps at the base of the penis. The inner apposed edges of the groin flaps are now sutured together in the median line over the raw surface of the turned-down abdominal flap, from a point close to the penile root upward as far as they will extend. The distal extremities of the denudation wounds are coapted with hare-lip pins, while the raw surfaces remaining are allowed to granulate and cicatrize. Great care is necessary in dissecting the flaps not to injure the peritoneum, also to handle them carefully without traction or forceps, for fear of subsequent sloughing. Nor must any great tension be put upon them in suturing; during which latter, and until healing is complete, the shoulders should be kept elevated and the thighs flexed, to secure utmost relaxation. By this operation, if successful, irritation is relieved, and all urine is delivered at a single dependent point, to which a urinal may be readily fitted and worn. The operation is attended with considerable danger.

In the female, an extra large abdominal flap should be cut, and the inguinal flaps should run down well into the labiæ, so that when all are coapted the vagina is also covered in. A large tube should be placed therein and frequently cleansed.

Pervious Urachus.

Pervious urachus may be partial or complete—the latter when it opens externally at the umbilicus. It is often associated with congenital absence or obstruction of the urethra. The canal may be much dilated.

The entire urinary secretion may pass from the umbilicus, a constant dribbling going on, or this may take place, in varying quantity, only when micturition is performed or attempted. The umbilicus and its surroundings become eczematous, and a granular red vascular prominence surrounds the urachal orifice, through which a probe may be passed, or perhaps a catheter or finger carried into the bladder. Calculi may arise in or be delivered from the bladder into the urachus and be discharged from the umbilicus. Any eczema about the umbilicus should excite suspicion and search for a patent urachus.

Treatment.—The treatment must first be directed to removal of obstruction causes; then the edges of the opening may be cleansed, pared, and deeply sutured.

Congenital vesico-rectal fistula, due to absence or defect of the posterior bladder wall, is irremediable, the patient usually soon dying from intense rectal irritation and diarrhœa. Other congenital vesical fistulæ are described elsewhere.

Displacements.

Displacements of the bladder are almost limited to females, except where the viscus has been drawn into the inguinal canal or scrotum as a constituent part of a hernia. Other displacements are: prolapse into the vagina (vaginal cystocle) or through the urethra. The latter, which is almost wholly confined to young children, may be complete (inversion) or incomplete. Complete prolapse presents a dark-red mass constricted about the base with the ureter orifices in sight. It may be reduced by continued gentle pressure and manipulation. To cut off or ligate the mass would be a fatal error.

Vaginal Cystocele.

Vaginal cystocele, of varying degree, is quite common in women who have become relaxed or torn hereabouts in childbirth. It protrudes, when distended, into the vagina or from the vulva as a globular, fluctuating tumor and may contain calculi. It may give rise to serious diagnostic error during, or to interference with, parturition. However, its nature can always be determined by passing a sound.

Treatment.—Excise one or more large oval areas of vaginal mucous membrane from the surface of the cystocele and suture the edges together from side to side. Any perineal tear should be repaired at the same time.

Cystitis.

Cystitis, or inflammation of the bladder, may be acute or chronic and involve one or all of the vesical walls. In a large majority of cases, however, the mucous membrane is alone affected. Any degree of inflammation from the mildest catarrh to that resulting in gangrene may prevail. Cystitis is almost always symptomatic of other troubles.

Acute Cystitis.

Acute cystitis is less common than chronic, which it may supervene upon or give rise to, and is most frequent in men. Usually it is caused by exposure, injuries, extension of septic or inflammatory affections from

the urethra (in gonorrhœa) or kidney, low fevers, the presence of foreign bodies or tumors, acute retention of urine, chemical and bacterial changes in the urine, ingestion of irritating drugs, by operations upon the organ, and by rough or unclean instrumentation.

Pathology of lesser degrees of acute cystitis corresponds with that of mucous membrane inflammation elsewhere. Where the process is more violent the lining membrane presents a dark crimson hue throughout, deepening to purple or even black about the neck, is ecchymosed, and in places may be necrotic and the muscular layer exposed. Hemorrhages may occur from bursting veins or separating sloughs; or perforation into the surrounding tissues or peritoneal cavity take place. Peritonitis may arise without actual perforation.

Symptoms.—Rigors or marked chill succeeded by burning pain in the bladder and glans penis, dull pain in the perineum, increased frequency of and spasmodic pain during micturition, and more or less fever, constitute the ordinary symptoms of acute cystitis. Pressure upon the bladder is intolerable. The urine may be blood-tinged throughout the attack, but more usually is replaced soon by pus and becomes ammoniacal. Acute retention is common.

If the exciting cause be promptly removed resolution usually at once takes place. Otherwise it may terminate fatally, or gradually subside into the chronic variety. The more violent forms are exceedingly dangerous.

Treatment.—The patient should be given a hot bath and be put to bed. Leeches should be applied to the perineum or hypogastrium and succeeded by poultices. The cause must be sought out and removed, if possible. Laxatives and mucilaginous or alkaline diluent drinks, perhaps aconite by mouth and anodynes by rectum, must be exhibited. If symptoms continue the bladder should be washed out once or twice daily, and, all these failing, perineal or supra-pubic cystotomy must early be resorted to. Retention is relieved by the catheter as often as necessary.

Chronic Cystitis.

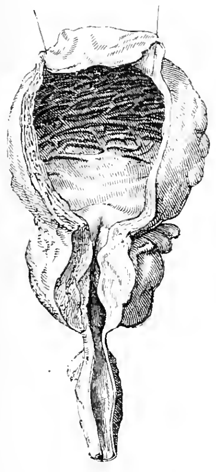
Chronic cystitis usually results from long-continued vesical irritation or follows an acute attack. It is an inseparable accompaniment to many disorders of the urinary tract, and is usually symptomatic of other disorders. Causes are: changes in the urine, presence of tumors or foreign bodies, retention of or residual urine, disease of the kidney, prostate or urethra, instrumentation, injuries, venereal excesses. Stricture is the most prolific cause.

Pathology.—The vesical mucous membrane becomes swollen, rugous, softened, and presents patches of capillary engorgement or ulceration. The epithelium desquamates rapidly; mucus at first and then pus is poured out in large quantity. The urine may be acid at first, but soon becomes alkaline and putrescent. Pus and mucus, also frequently blood, are prominent features. Decomposition precipitates the urinary salts, and calculi or calcareous deposits upon the bladder walls are of frequent occurrence. When the disease has been of long duration the muscular wall becomes either hypertrophied and contracted, or its fasciculi become irregularly stretched apart while the mucous membrane sinks into the intervals, giving rise to the condition known as sacculated or ribbed bladder. These depressions or sacs may become large and retain decom-

posed urine, act as receptacles for calculi, or perforate and give rise to peritonitis or peri-vesical abscess. The ureters and kidneys sooner or later also become involved, and add greatly to the seriousness of the disease.

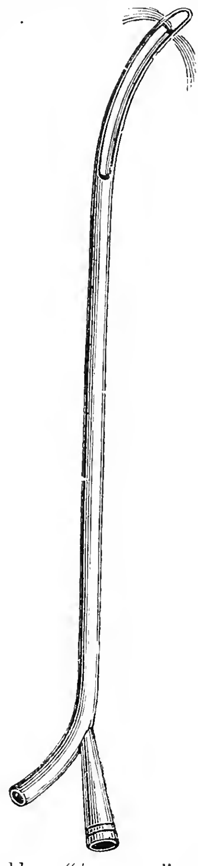
Symptoms.—The symptoms are mainly those of the acute variety, but in milder degree. Only slight fever is ever present, but the combination of pain and other distress rapidly undermines the general health. Renal implication makes a general breakdown even more rapid. The urine is turbid, alkaline, and contains much mucus and pus, which forms a tenacious clot at the bottom of the retaining vessel. The bladder wall in late stages will be found ribbed and sacculated by the exploring sound.

Fig. 406.



Enlarged prostate with ribbed and sacculated bladder. (Druitt.)

Fig. 407.



Double or "two-way" catheter for washing out the bladder.

Treatment.—The cause must be found and removed. Rest in bed is essential; no exposure of any kind must be allowed. Milk is the best diet. Drugs, such as quinine, capaiba, buchu, oil of sandalwood, salol, and laxatives are useful for their general or local effects. Depletion by leeches to the epigastrium or perineum and hot local applications are both curative and comforting. If, with the above, symptoms do not rapidly subside, the bladder should be washed out once daily, at first with simple hot water, but later with antiseptic solutions of gradually increasing strength as the organ becomes more tolerant: such as nitrate of silver (gr. 1 to oz. 1 of water), borax (gr. 5 to oz. 1 of mucilage-water), nitric acid (♏ 1 to half-pint of water), and, especially where urinary decomposition is excessive, quinine bisulphate (gr. 2 to oz. 1). An injection of a grain of morphia in two ounces of water and allowed to remain in the bladder will give ease or a good night's rest in many cases.

These methods having failed, nothing remains but to perform perineal cystotomy, which gives permanent drainage and rest to the bladder. In women this latter can be accomplished by dilatation of the urethra, or by making an artificial vesico-vaginal fistula.

Tuberculosis of the Bladder.

Tuberculosis of the bladder is not so rare an affection as formerly was thought. It occurs most frequently in males, and between the twentieth and fiftieth year. Generally it is secondary to disease elsewhere; when primary the prospect is more favorable. There are two favorite situations for this disease—namely, near the trigone and upon the posterior wall, the former being almost invariably secondary to prostatic tuberculosis.

Symptoms.—The symptoms resemble closely those of calculus. There is usually great pain, tenesmus, and contraction of the bladder; blood. pus, and tubercle bacilli in the urine. The cystoscope shows the mucous membrane at first thickened in patches and infiltrated with gray miliary tubercles. These patches later break down, leaving deep, irregularly-round ulcers with infiltrated edges and perhaps surrounding œdema. Rarely these perforate; should they heal, a distinct scar remains. When the disease is primary and can be reached by appropriate treatment, the outlook is fair; but when otherwise, is most unfavorable.

Treatment.—When primary (never otherwise) and favorably situated, the disease may be reached and thoroughly curetted out after suprapubic cystotomy has been performed.

Vesical Neuroses.

Neuralgia, irritability, and spasm of the bladder, while they may very rarely be pure neuroses, yet usually can be traced to causes just beginning to originate cystitis; of which, indeed, they are frequent precursive symptoms. On the other hand, reflex nervous phenomena arising from the prepuce, urethra, kidney, or spine, and appearing as vesical affections, are by no means uncommon.

Paralysis.

Lack of contractile power more or less marked and prolonged may follow retention of urine, be reflex or hysterical, or due to serious brain or spinal lesions. Treatment should include: prevention of urinary retention or decomposition, and attempts to remove the cause and restore the lost power.

Atony.

Atony is the term applied to slight degrees of lack of contractile force in the bladder wall. It is usually senile in origin, but may be brought about by disease at any age. Treatment is practically the same as for paralysis.

Vesical Fistulæ.

Fistulæ are rare, except in women. In men they result from non-closure of accidental or surgical wounds, and from ulceration through the bladder wall. They may terminate in intestine or upon the perineum, abdominal

wall, or thigh. In women parturition furnishes the most fruitful cause; here they are most apt to open into the vagina or uterus. Diagnosis is usually palpable. Treatment is considered elsewhere.

Tumors of the Bladder.

The primary tumors which occur in the bladder are, in order of relative frequency: papilloma, carcinoma, myxoma, sarcoma, fibroma, and myoma. All have a marked tendency to become pediculated. Secondary tumors are exceptional, unless by extension from contiguous parts. Dermoid cysts of the bladder have been described, but they invariably find their way into the viscus by ulceration from without.

Papillomata.

Papillomata are met with, as a rule, in men after puberty, but any age or either sex may give them origin. While usually single and sessile, yet the entire bladder wall may become involved. Urinary salts may become deposited upon the growths and give rise to a false diagnosis of calculus. The vesical floor about the ureteral openings is their usual situation. In structure they conform to the usual type of papilloid growth, and are covered with luxuriantly proliferating bladder epithelium. Those developing in the aged are very prone to carcinomatous changes.

Carcinomata.

Carcinomata are frequent in those of advanced years, and in situation correspond with papilloma. They generally have a broad base but may likewise become pediculated; the surroundings are always more or less infiltrated.

Myxomata.

Myxomata or polypoid tumors are almost limited to childhood. They correspond pathologically with nasal polypi; are often multiple, form with rapidity, and may prolapse from the female urethra or obstruct that of the male.

Sarcoma, fibroma, and myoma are exceptionally rare in this situation.

Symptoms.—The symptoms of bladder tumor correspond mainly with those of foreign bodies. The first sign of papilloma and myxoma is hemorrhage. Blood may be suffused through the urine, appear in clots, or be passed almost pure; it may be continuously present or intermittent, but instrumentation always brings on or aggravates the hemorrhage. Later, pain, tenesmus, and perhaps cystitis set in. When the tumor is malignant, however, symptoms of vesical irritation or inflammation precede hæmaturia. Portions of the growth may pass with the urine, or be removed by instruments and perfect the diagnosis. In benign tumors pain is a late, usually not prominent, symptom, while in malignant disease it occurs early and is very distressing. Cachexia and advanced age also point to the more serious affection.

Rectal, abdominal, vaginal, and direct digital examination through a perineal wound made for the purpose (external urethrotomy) are valu-

able aids to diagnosis, but nothing can equal the visual assistance afforded by the cystoscope. Digital examination of the female bladder may be made through the dilated urethra.

PROGNOSIS.—The outlook for cases of malignant disease is invariably fatal, but a partial removal of the growth may give comparative comfort and much delay the fatal issue. Happily, benign tumors are now available for successful operations, and, while always serious, are no longer commonly fatal.

Vesical hemorrhage is rarely fatal, *per se*, but weakens the constitution and may give rise to putrefaction in the organ. Cystitis is a troublesome and dangerous complication, as it reduces the patient by increasing his discomfort.

TREATMENT.—Papillomata and other benign growths should be promptly removed by supra-pubic or perineal section, and gently tearing them away with the finger-nail, fingers, forceps, curette, or knife. Or, if a large pedicle is present, by an écraseur. Occasionally, one may be delivered from the wound and ligated off. Still again, the cautery, which is always useful to check hemorrhage after removal, may be employed for their destruction. Vinegar here is a most excellent hæmostatic. From the female bladder certain tumors may, in like manner, be extracted through the dilated urethra; others by incision through the anterior vaginal wall or by the supra-pubic operation.

Secondary or metastatic tumors of the bladder are invariably malignant, hopeless, and require but palliative treatment.

VESICAL CALCULI. (STONE IN THE BLADDER.)

Vesical calculi are found at all ages, but principally after the fiftieth and between the second and thirteenth years. Stone may be congenital. It is much more common in males than in females, because of the difficulty of escape for small concretions and the much greater prevalence of genito-urinary disorders, dissipation, and exposure amongst the former. Negroes, and the people of certain districts, are almost exempt from calculi, while in other localities, especially where the water is "hard," stone is most common.

CAUSES are: (1) predisposing, and (2) exciting.

1. Heredity, drinking-water, gouty or uric acid diathesis, indigestion, dissipation.

2. Disease of any portion of the urinary tract, presence of foreign bodies, or any cause producing irritation of the bladder, such, particularly, as retention or decomposition of urine.

CONSTRUCTION.—Most vesical calculi are composed of a nucleus upon which have been deposited successive layers of urinary salts, all of which may be made evident by sawing the stone in half. The nucleus may consist of inspissated blood, pus, epithelium, mucus, an aggregation of crystals, or a true foreign body, such as a piece of catheter, splinter of bone, bullet, etc. Upon it may be deposited layer upon layer of the same salt, or deposits of varying precipitates may, from time to time, according to changing conditions, add to its bulk and give rise to what is called the *alternating* calculus.

NUMBER.—Stones are most commonly solitary, but two or more are frequently met with, and, rarely, great numbers are encountered. Soft stones may partially disintegrate and become fractured by bladder con-

traction or by concussion against one another when multiple, thus increasing the number present. The more quickly formed and softer stones are more apt to be multiple; oxalic and uric acid calculi are almost always solitary.

PROPORTIONS.—The usual weight of bladder-stones is from three to six drachms; but they may be found ranging from that of a grain or two up to many ounces. A stone weighing over four pounds has been removed from the human bladder *post-mortem*. *Form* depends upon the position of origin and detention; the stone may correspond in shape with the pelvis of the kidney, with that of a saccule or other portion of the bladder, but more especially with that of the nucleus. The average calculus is flattened, oval, or round, and may be smooth, granular, or roughly tuberculated. Multiple stones are apt to be flat, irregular, and to be faceted at points of mutual contact.

CONSISTENCE depends upon the composition. Those composed of oxalate of calcium or uric acid are excessively hard, while phosphatic stones vary from the firmness of soft brick to that of dried clay.

VARIETIES.—The usual types of vesical calculi, in order of relative frequency, are: (1) uric acid, (2) oxalate of calcium, and (3) phosphatic. These ingredients may be almost pure, or intermingled in various proportions or in alternating layers.

1. This variety is chiefly limited to youth and middle age; almost always descends from the kidney, and constitutes the nucleus of most other varieties. They are of slow growth, moderate proportions, smooth, regular surface, dark-brown color, and develop in acid urine.

2. (Mulberry calculus.) Are more slow in development, and harder, also rough and irritating. They chiefly appear during middle age.

3. Of this type there are three varieties: (*a*) phosphate of calcium (earthy phosphates); (*b*) ammonio-magnesium phosphate (triple phosphates), and (*c*) phosphates of calcium, ammonium and magnesium in varying combination or mixture (mixed or fusible phosphates). Varieties *a* and *b* are unusual; *c* is the common representative of the phosphatic group. They are large, irregular, soft, white, generally have a nucleus of harder calculus or foreign body, and originate in alkaline urine, usually during later life.

Other possible but very rare varieties of stone are composed of cystic oxide (cystine), xanthic oxide, and carbonate of calcium or magnesium. Certain organic substances by inspissation and concretion sometimes form foreign bodies in the bladder which, to all intents and purposes, resemble true calculi. These may be fibrous, sanguinous, or urostealithic.

PROGRESS.—If stones are not promptly removed—perhaps in any case—cystitis and involvement of the kidneys may result. The possibility of such changes being present must be borne in mind when operative interference is contemplated. Stones, if neglected, may ulcerate through the vesical wall into the perineum, rectum, or vagina, or by their presence in the bladder impede or prevent childbirth. Small calculi not infrequently (especially in the female) are passed *per urethram*.

SYMPTOMS of vesical calculus are chiefly those of the inflammatory and tubercular affections of the organ which have already been described. There is the pain of cystitis, but perhaps only present at the end of micturition, when the stone is forced upon the sensitive trigone or neck; it is, in fact, referred to the end of the penis, or elsewhere, as a rule, and, in children, the prepuce may become very long and redundant from constant pulling to relieve the pain there felt.

Often it is more easy for the patient to pass water in certain positions, as upon the back, side, or belly. Pain is least at night, and when the person is quiet; jolting and exercise greatly aggravate symptoms.

Frequent irresistible desire to micturate is an early and prominent symptom. The act may be suddenly cut short by the stone falling against or into the vesical outlet. Blood is passed in greater or less degree, continuously or intermittently. Priapism and incontinence are common in children. Often there is agonizing tenesmus of the bladder and rectum at the end of micturition, when the stone is grasped by the bladder wall. The urine corresponds to that passed during cystitis, but with the presence of a greater proportion of blood, as a rule. Normal urine, and entire absence of symptoms, are not absolutely incompatible with the presence of even moderate-sized stones.

Diagnosis.—A history of inheritance, gouty diathesis, previous calculus, or of renal colic, may render diagnosis more easy, but scarcely any symptom or group of symptoms is pathognomonic. Stone may complicate other diseases, while almost all urinary affections present symptoms precisely similar to those arising from calculus. Hence physical demonstration of a stone's presence must invariably be secured before diagnosis is made or operation attempted. This can be accomplished by means of the metallic sound. Stones may occasionally be felt by rectal, vaginal, or bimanual palpation.

Sounding the Bladder.

The patient should recline upon a table or bed, with hips elevated, and the bladder moderately distended by accumulated urine or injection of warm water. Anæsthesia is often necessary in children, or where examination causes much suffering. "Gentleness," should be the watchword in all

Fig. 408.

Type of sound.

bladder manipulations. The sound is made of steel, about 17 mm. in diameter, with a dull, short beak curved upon the shaft to an angle of 120°. A much smaller size is requisite for children.

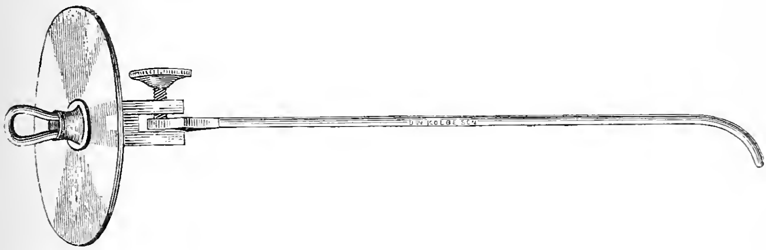
This instrument is inserted in the same manner as a catheter, and its point carried in a gentle jerky manner systematically over the entire vesical area. The point is first turned into the base and trigone, then above the pubis, and finally over the other portions of the viscus. If no stone is found, a finger is inserted into the rectum or vagina, and, while pressure is made upon the abdominal wall, the organ is again gone over. Still failing, the urine should be withdrawn and examination repeated.

These successive manœuvres having been carried through without loss of time, further efforts should not be made, but the patient quickly gotten to bed, and kept warm. Several days later he may be again sounded, when, with the familiarity which has been gained in the former examination, the stone, if present, will generally be discovered. Diagnosis of some sacculated calculi, or those rare instances of pediculation or suspension of a stone by a lymph-band, may be impossible short of

operative exploration. Non-discovery of a stone by sounding may be taken as presumptive, but never as *absolute*, proof of its absence.

When the instrument comes in contact with a calculus, a grating sensation and click are produced. These may be greatly amplified by a sounding-board attachment. The sensations arising when a stone is struck

FIG. 409.



Sounding-board attached to sound.

are totally different from those arising from the instrument impinging upon the pelvic bony prominences, or from rubbing over a tumor or mucous membrane coated with phosphatic deposit. Confusion could only arise with those who had never experienced the former. The presence of two or more stones can be decided by seizing one in the jaws of a lithotrite and then striking another with the instrument.

A stone having been found, it is important to determine its approximate size, shape, composition, and whether or not it is encysted. Size and shape can be ascertained by an experienced operator by passing the sound around and across it, but the better plan is to measure the distance to which the blades of a lithotrite must be separated to grasp it. Composition is roughly determined by the size, history, condition of urine, roughness of surface, and contact sensation. *Encysted stones* are always found at the exact spot where they were first encountered, and cannot be moved or seized by the lithotrite.

After sounding put the patient to bed, keep him warm, and administer —if it has not been done beforehand—a full dose of quinine; also, if pain should follow, an opium (one grain) and belladonna (one-quarter grain) suppository.

TREATMENT.—The presence of calculus having been determined, the imperative indications are to remove it and to treat any remaining pathological conditions of the bladder.

Attempts to dissolve the stone *in situ* are not permissible; operation alone must be resorted to. If the patient is run down and exhausted, a betterment of his condition by rest in bed and milk diet should be attempted before undertaking removal of the stone. It is always best to thus treat the patient for a few days prior to operation. Where grave kidney changes exist, palliative treatment by anodynes may alone be sanctionable.

There are two chief methods of removing a stone: (1) that by a crushing and (2) that by a cutting operation, and it is often most difficult to judge which is best for the case in hand.

1. Crushing (lithotrity and litholapaxy) is generally best suited to cases where the stone is neither too large nor too hard; where no serious urethral, prostatic, bladder, or kidney complications exist; where the

organ will hold three or four ounces of fluid, and when the nucleus is also crushable. Tumors of the viscus contra-indicate this procedure; also stricture, unless it can first be thoroughly relieved. Conditions of paralyzed, atonic, or sacculated bladder, while unfavorable, do not absolutely prohibit its employment. Sacculated stone is usually a positive contra-indication.

For crushing, hard stones must not be larger than three-quarters of an inch, and soft ones one and a half inches in diameter.

2. Cutting operations include (*a*) lateral (and bilateral) or sub-pubic lithotomy, and (*b*) supra-pubic lithotomy. They should never be performed save when crushing is inadvisable. *a* is, as a rule, best suited to cases presenting grave complications, such as those of urethra, prostate, and kidney, and to very aged persons; also where it is necessary to complete the removal in the shortest possible time. Children stand this operation extremely well. Calculi larger than one and a quarter inches should not be removed by this route. *b* is adapted to all stones larger than one and a half inches, to those complicated by tumors, and to persons who suffer severely from "urethral fever."

Calculi in the female bladder are removed, according to size and complications, by forceps through the dilated urethra, crushing, cutting through the vesico-vaginal septum, or by the supra-pubic operation.

Stone returns in about 4 per cent. of all cases operated upon by this method.

Foreign Bodies in the Bladder.

Foreign bodies are frequently met with in the bladder. Such include: pieces of broken instruments, as lithotrite blades, catheter ends, etc., bodies inserted into the urethra with lascivious intent or to relieve retention; also those coming into the organ through wounds, such as bullets, chips of shells, bits of clothing, splinters of wood or bone; by ulcerative processes, as fœtal remains, sequestræ; or, through vesico-intestinal fistulæ, feces, fruit-stones, or parasites. Hydatids may descend from the kidney.

Bodies when retained in the bladder usually form nuclei for calculous deposit. Symptomatology and diagnosis correspond with that of stone. History is usually most obscure.

Treatment.—Give nature a fair chance to expel the body. Then try to extract or crush with the lithotrite, or wash out with the lithotrity apparatus. Glass should not be crushed, and care must be taken not to close the lithotrite strongly upon soft substances, for fear of impacting its blades. These measures failing, supra-pubic cystotomy should be promptly done.

Injuries of the Bladder.

Contusions are often followed by blood-tinged urine and cystitis. Treat as if beginning acute cystitis.

Wounds arise from direct or indirect force applied from within, as instrumentation or rupture; or from without, as shot and stab wounds, or puncture by a fragment of broken pelvis. Of these varieties there are two great classes: the (1) intra- and (2) extra-peritoneal.

1. *Intra-peritoneal wounds* are usually accompanied by great shock, hypogastric pain, inability to micturate, nausea, vomiting, perhaps hiccough, signs of fluid in the peritoneum, and later, signs of peritonitis

and absorption of urinary products by the peritoneum. The catheter (which should be perfectly aseptic) may bring away either a large amount of blood-tinged or clear urine, none at all, or pure blood. Perhaps the instrument can be inserted unnaturally far and be felt among the intestines through the abdominal wall.

Diagnosis may be made or confirmed by injection of air through a catheter and noting absence of tympanitic bladder distention, while the whole abdomen becomes tympanitic; or by exploratory abdominal section where other means fail.

TREATMENT.—Where intra-peritoneal rupture or other wounds exist, immediate abdominal section in the median line low down must be performed. Any foreign body present must be removed and the rent sutured with Lembert stitches, six or more to the inch. The abdominal cavity is then freely washed out and the parietal wound closed, leaving in a glass drain to the pelvis. If it is impossible to suture the tear, the tube alone must be relied upon. The urine should be drawn at frequent intervals for the first week, or a soft catheter may be tied in the urethra.

2. *Extra-peritoneal wounds* are often, short of abdominal section, exceedingly difficult to diagnose from those involving the peritoneum. Usually there is shock and copious hemorrhage from the urethra, desire to urinate and great pain. Extravasation of urine generally soon appears in the perineum or lower abdominal wall.

TREATMENT.—Perineal section and drainage, with free slitting up of infiltrated areas, are the prominent indications.

RETENTION OF URINE.

This disorder may be (1) acute, or (2) chronic, complete or incomplete. Causes may be mechanical, functional or organic. Retention must not be confounded with *suppression* of urine.

CAUSES.—1. Impaction of calculi or foreign bodies in the urethra, or changes in the urethral wall due to strictures, inflammation, tumors, outside pressure, enlarged prostate, blood-clots or abscesses, also nervous influences, more especially after operations upon the genito-urinary organs or rectum, are the most common causes of acute retention.

2. Here the bladder itself may be at fault, being powerless, through paralysis or atony, to discharge its contents, or a combination of causes usually giving rise to the acute variety may establish the chronic retention.

COURSE.—The bladder becomes over-distended and appears as a rounded tumor, yielding a flat percussion note in the lower abdomen above the pubic symphysis, and may extend to, or in old cases even above, the umbilicus, and without care give rise to false diagnosis. In long-standing cystitis with contracted bladder the tumor may be very small and yet give rise to the utmost distress, while, on the other hand, a bladder holding many pints, distending the whole abdomen, and of weeks' duration, may not be complained of. The organ very rarely ruptures unless subjected to traumatism. More usually, when its extreme limit of expansion has been reached, small amounts of urine are forced by the great pressure through the obstruction to its outflow, and constant or intermittent dribbling from the urethra takes place. Where incontinence is complained of, the state of the bladder should always be examined into. Rupture of the urethra behind an obstruction—especially if the impediment be an old stricture—is by no means an uncommon result of extreme retention.

The back pressure in the ureters and pelvis of the kidney dilates those parts, or may develop serious disease therein. The bladder, after relief of severe retention, usually remains paralyzed for a longer or shorter time and is highly predisposed to putrefactive and inflammatory changes.

SYMPTOMS.—If acute, there is much pain and distress, little or no urine is passed, and tumor, as above, appears. Pressure in the hypogastrium is intolerable. A finger introduced into vagina or rectum perceives the bladder pressing down, and impulses upon the abdominal wall are transmitted to it. Typhoid symptoms accompany some cases of long standing. When onset is gradual the subjective symptoms are less severe; dribbling of urine may alone be complained about.

TREATMENT.—The methods of relieving retention are: the catheter, if it can be passed; supra-pubic aspiration repeated twice daily for days, if necessary; perineal cystotomy, which latter will often permanently cure such causes as enlarged prostate and stricture. When obstruction is due to vesical calculus or tumor, retained blood-clots, etc., supra-pubic cystotomy is preferable. After-treatment must be directed to removal of both cause and results of the malady. Hemorrhage may take place from engorged vesical veins if pressure is relieved too suddenly by rapid withdrawal of the accumulated urine. Kidney symptoms must be treated if they arise.

SUPPRESSION OF URINE.

This is a most dangerous and fatal condition, in which secretion of urine by the kidneys ceases. Previous kidney disease, aggravated by the effects of anæsthesia and operations upon the urinary organs, is the usual cause, but it may supervene during or after retention. Symptoms are those of acute uræmia. No urine comes into the bladder. Treatment is almost universally futile.

INCONTINENCE OF URINE.

Of this there are three varieties: 1. True incontiuence, where the urine dribbles as fast from as it is poured into the bladder. 2. Nocturnal, where, independent of disease, urine is passed during sleep. 3. False incontinence, the result of retention.

1. May be due to atony or paralysis resulting from spine or cerebral disease, over-dilatation of the urethra; or certain tumors, or localized hypertrophy of the prostate or bladder, interfering with the vesical sphincter. Treat by removing the cause, if possible.

2. This is practically limited to children; is an involitional act dependent upon reflex inhibition of the sphincter vesicæ resulting from some irritation of the alimentary or genito-urinary tracts, such as seat-worms, phimosis, polypus, stone in the bladder, or indigestion.

The cause should be removed, and tonics, laxatives, and small doses of belladonna will be useful. The child should never be punished.

HÆMATURIA.

Hæmaturia, or blood in the urine, is usually indicative and the result of disease or injury at some point in the urinary tract, but may result from purpura hæmorrhagica, scurvy, fevers, or to the ingestion of such

drugs as cantharides, turpentine, carbolic acid, or to the presence of parasites (*Bilharzia hæmatobia*). It may be continuous or paroxysmal, according to the cause. Its presence in the urine is indicated by the color and confirmed by the microscope. The amount of blood may be trivial or enough to compromise life. If it remain long in the urine, the corpuscles decompose and the liberated hæmatin imparts a dark smoky hue to the urine.

The *source of the blood* may be approximately determined by its proportionate amount and the occasional presence of structures recognizable by the microscope; also, by the condition of the blood; whether decomposed, clotted, in casts, etc. Usually, when of kidney origin, it is intimately mixed with the urine; when from the ureter the same, or in long clots or fibrinous casts; when from the bladder or prostate, it comes after or in the last portions of urine; when from the urethra, in the intervals of or during the early stages of urination—either pure, almost so, or in casts corresponding to the urethra.

Treatment.—Control causes as elsewhere described. Clots in the bladder soon decompose and give rise to serious effects. They should be dissolved by digestive ferments, broken up and washed out by the lithotrity evacuator, or removed by supra- or infra-pubic cystotomy.

Pneumo-uria.

Escape of gas with the urine. The gas always originates from: introduction through instruments, fermentative processes in the bladder, or vesico-rectal fistulæ.

Chyluria.

Chyluria, or escape of milky chylous fluid with the urine, is caused by lodgment of the filaria or hæmatode worm in some portion of the urinary lymphatic system, with consequent engorgement and rupture of lower lymphatic channels and pouring out of lymph into the urinary canal.

Operations upon the Bladder.

Aspiration.

The surroundings are made aseptic and the outline of the bladder mapped out by percussion. The aspirator needle is then, avoiding veins, thrust through the abdominal wall one inch above the symphysis pubis in the median line. Anæsthesia by freezing, together with a slight skin incision, renders the operation almost painless. A small antiseptic dressing should be applied after withdrawal of the canula.

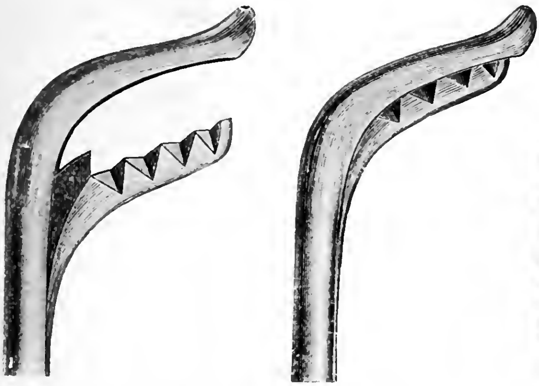
Lithotrity.

Lithotrity, or the extraction of a stone by crushing, is here meant to include both crushing and removal of resulting fragments. Sometimes the name *lithotrity* is applied to simply crushing the calculus and allowing (as in former times) the fragments to come away subsequently with the urine; *litholapaxy* to crushing and immediate evacuation of the débris.

The patient's general condition having been improved as much as possible, all strictures well dilated, and the meatus incised if it is nar-

row, he is placed upon a table with his hips raised six inches and a pillow beneath the knees. Anæsthesia is always necessary. The thighs are separated and the urine drawn. From five to eight ounces (according to its capacity) of warm water are injected into the bladder and the lithotrite gently inserted. The blades after introduction should look upward

Fig. 410.



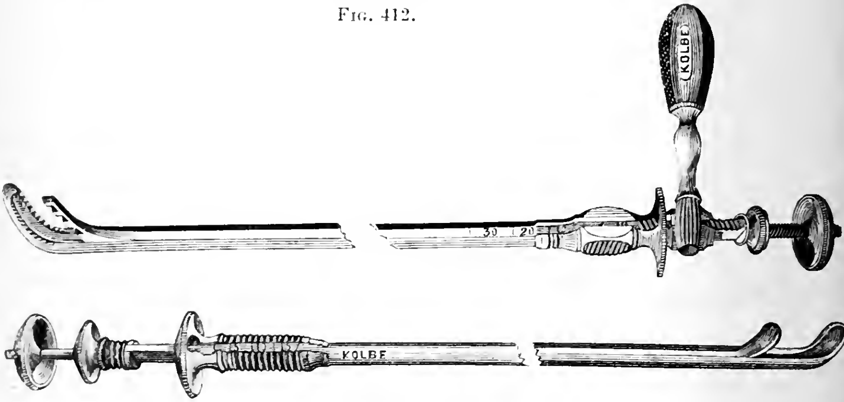
Jaws of Bigelow's lithotrites, exact size.

Fig. 411.

Jaw of fenestrated lithotrite.

and rest upon and slightly depress the floor of the organ. Now, holding the handle of the instrument firmly with one hand, pull out the sliding or "male" blade two inches. Wait a second to let the stone settle and then push the blade home again. If the stone is caught throw on the screw mechanism until the calculus is securely fastened between the jaws. Lower

Fig. 412.

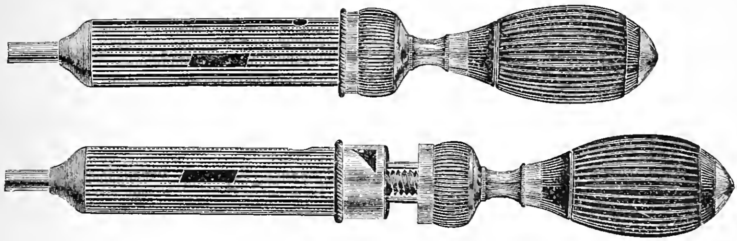


Ordinary lithotrites.

the handle to carry the stone and blades away from the bladder-wall. If there is any resistance to this movement mucous membrane probably has also been caught and the stone must be let go and again ensnared. Otherwise the blades are at once screwed together until the calculus is crushed between. Then each resulting fragment must be likewise caught and crushed. If the stone does not at once fall into the instrument, as above,

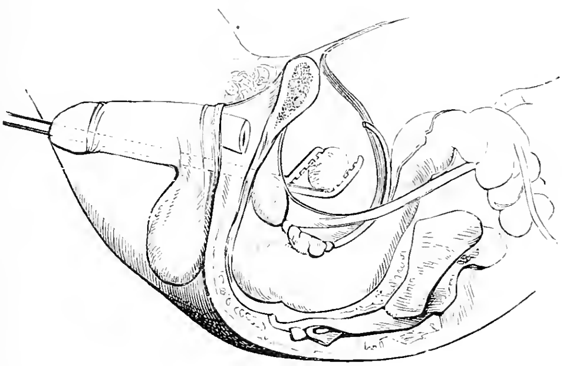
the blades are reopened and carried above the symphysis by depressing the handle. This failing, they are rotated through a half circle from side

Fig. 413.



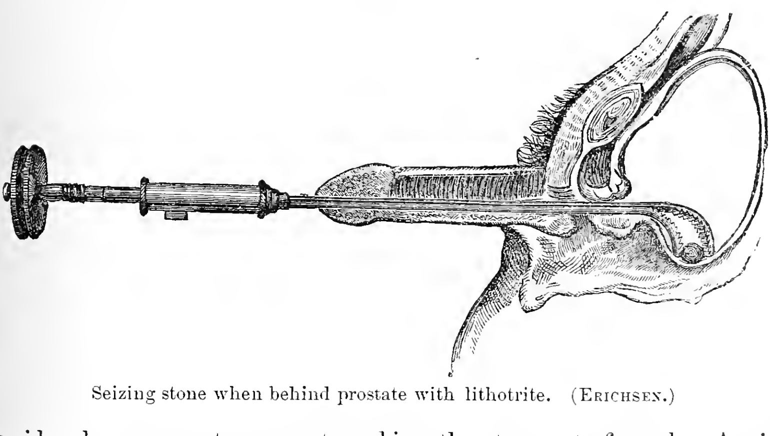
Handles of Bigelow's lithotrites.

Fig. 414.



Position of lithotrite in crushing stone. (Liston.)

Fig. 415.

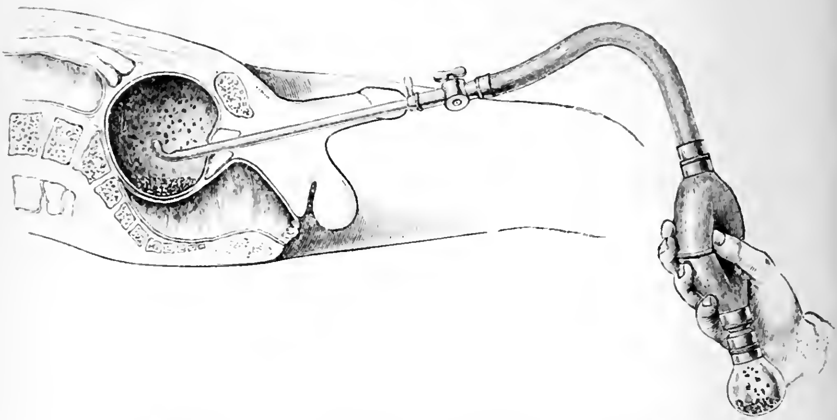


Seizing stone when behind prostate with lithotrite. (Erichsen.)

to side, always open to prevent pushing the stone out of reach. Again failing, the blades are rotated until they point to the rectum, the handle is raised, and the bladder behind the prostate explored, always remembering

to carry the jaws away from the bladder-wall before crushing. A stone having been caught in any situation and crushed, the fragments always

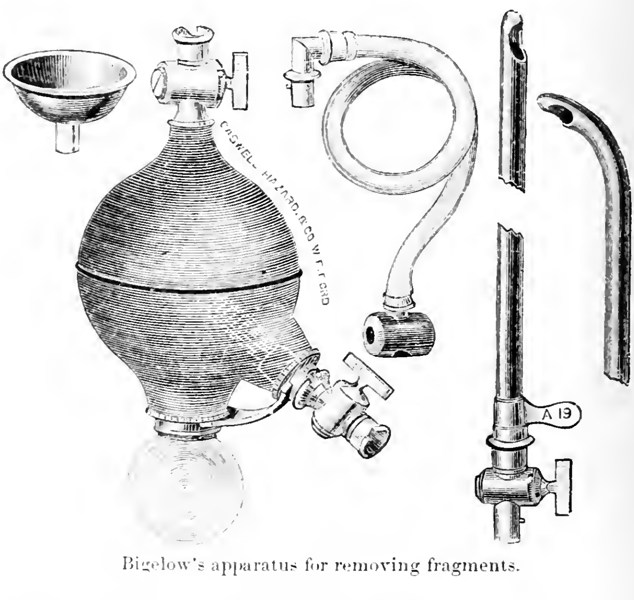
Fig. 416.



Removal of fragments by Bigelow's evacuator. (Erichsen.)

fall vertically and can be secured by the first or last described manœuvres and successively crushed. When all have been broken to small fragments, the blades are screwed firmly home and the instrument withdrawn.

Fig. 417.



Bigelow's apparatus for removing fragments.

drawn. A large and powerful crusher may be used to break large or very hard stones and a smaller one to deal with the fragments.

Now introduce the largest evacuating catheter that the urethra will

accommodate, allow all fluid to escape from the bladder, and then inject into it about three ounces of water. Connect the bulb with the catheter and inject rather suddenly from it, by compression, about as much more. Quickly release it, when the return current, induced by expansion of the bulb, will draw into it a quantity of débris and fragments. Give these time to settle into the receiver below the bulb, and then repeat the act again and again until no more fragments are withdrawn. Great precaution must be taken to ascertain previously the extreme capacity of the bladder and not to inject more fluid than it can hold without tension. Otherwise it may be ruptured. The evacuator is then taken out and the organ explored by the sound. If any fragments remain they must at once be crushed and removed. *Dangers* to be feared are: suppression of urine, rupture of the bladder, and impaction, bending or breaking of the lithotrite while in the bladder.

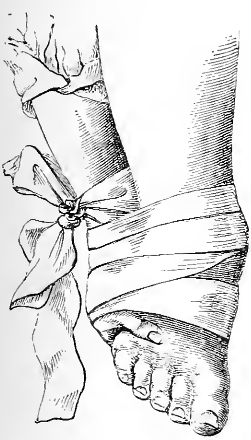
Perineal Cystotomy (and Lithotomy).

There are two methods of performing this operation, *lateral* and *median.*

Lateral Perineal Cystotomy (and Lithotomy).

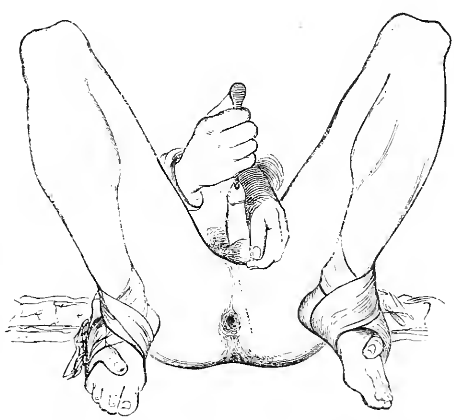
The bowels are previously well cleared by laxatives and an enema just before operation, and the parts well shaved and cleansed. Anæsthesia is essential. The hips are brought to the edge of a table and the legs fastened in the "lithotomy position" by bandages, shackles, or a crutch. The urine is drawn, the bladder moderately distended by injection of warm water, and a centrally grooved staff introduced into it and held steadily upright in the median line against the under surface of the pubis by a skilled assistant.

Fig. 418.



Method of securing hand and foot for lithotomy. (Druitt.)

Fig. 419.



Position of patient and line of incision in lateral lithotomy.

The surgeon sits facing the perineum between the patient's legs. He inserts his left index-finger into the rectum to make certain that it is empty, to cause it to contract and to act as a guide; and with his right

hand makes a cutaneous incision from a point in the raphe one and a quarter inches in advance of the anal margin, downward and outward to a point on a level with, but one-third nearer to, the left tuber ischii than the anus.

FIG. 420.

Grooved staff for lithotomy.

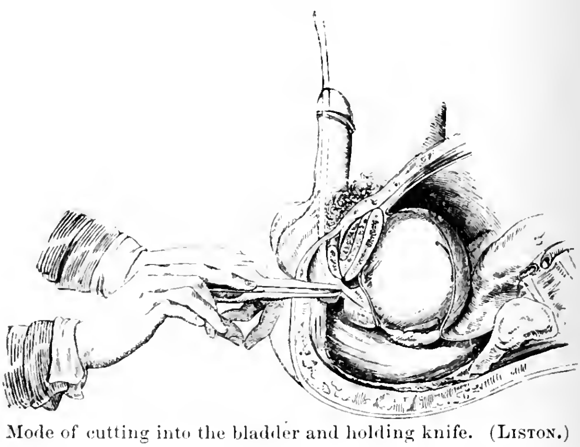
This incision divides skin, superficial fascia, the external hemorrhoidal, and, perhaps, the superficial perineal vessels and nerves. A finger now thrust into the wound locates the staff, and all structures are divided

FIG. 421.

Lithotomy knife.

down thereto, and, the finger acting as guide, the point of the knife is engaged in the groove. This cut severs the transverse perineal muscle and artery, the lower border of the triangular ligament, and punctures

FIG. 422.

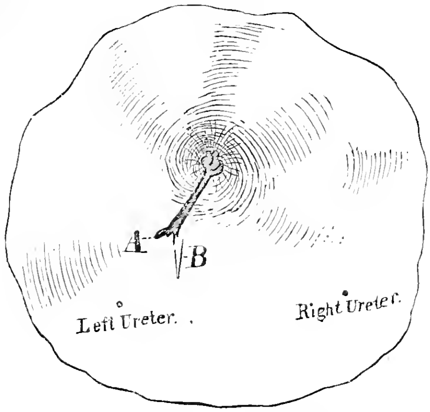


Mode of cutting into the bladder and holding knife. (LISTON.)

the accelerator urinæ muscle and urethra. Now, while the knife is held in a horizontal position and deviated slightly to the right, it is pushed along the groove into the bladder. A gush of water through the wound announces that the viscus has been entered. This cut divides the mem-

branous urethra and floor of the prostate. As the knife is withdrawn its handle should be depressed so as to deepen the prostatic incision. Any subsequent cutting that may be necessary should be done with a hernia

FIG. 423.

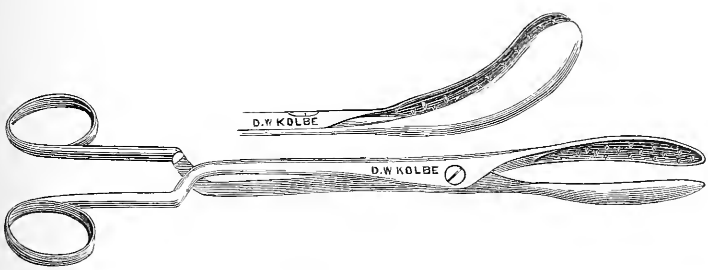


Lateral lithotomy. Incision of the neck of the bladder as seen from within. *A* is a rent in the wall made by introduction of the finger. *B* is an extension of the incision involving only the mucous membrane. (STIMSON.)

knife or blunt-pointed bistoury. The staff is next removed and the left index-finger thrust through the wound into the bladder.

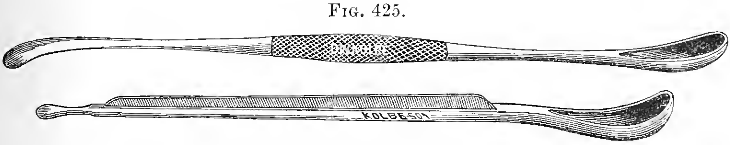
If the perineum is very deep, a blunt gorget may be introduced *before*

FIG. 424.



Lithotomy forceps.

FIG. 425.



Lithotomy scoops.

the staff is withdrawn. This terminates the operation of *cystotomy*, but if the extraction of a stone (lithotomy), foreign body, or tumor is contemplated, straight or curved forceps, guided by the inserted finger, must be

44

employed for the purpose. If the stone is found to be too large for extraction without severely bruising or stretching the parts (which is always dangerous), and cannot be broken by forceps or lithotrite into more manageable size, perineal extraction must be abandoned, and the suprapubic operation performed. Blood-clots, etc., should be flushed out of the organ before the patient leaves the table. No sutures are required.

Dangers.—Wounding of the rectum, posterior bladder wall, prostatic capsule, or prostatic plexus of veins, the artery of the bulb, or an anomalous pudic vessel, constitute the chief dangers. Tearing of the bladder wall also may take place in removing bodies with forceps.

After-treatment.—No dressings need be applied. The patient should be placed upon a bed with mackintosh and draw sheets—the latter to be changed as often as required. If the urine does not flow out freely a canula may be tied in the bladder. Primary or secondary hemorrhage may be promptly checked by ligation or cauterization of the bleeding points, if they be in sight, or by inserting a "shirted catheter" into the bladder, and packing the "shirt" firmly with strips of gauze. These failing, direct digital pressure by relays must be kept up until it ceases. During the first few days succeeding operation all urine escapes through the wound. Then, owing to slight obstructive swelling therein, a portion may come through the urethra; after a day or two more, tumefaction subsides, and all again passes through the wound, until, as it gradually cicatrizes, more and more, and finally all, is passed *per urethram*. Should perineal fistula remain, it should be stimulated, or its edges pared and sutured. (See Urinary Fistula.)

Fig. 426.

Shirted catheter.

Median Perineal Cystotomy (and Lithotomy).

Preparations, up to incision, as have been described for the lateral operation. Incision is made exactly in the perineal raphé from one and a half inches above the anal margin downward one to one and a quarter inches. The left index-finger guarding the rectum, the incision is carried down until the urethra is opened and the point of the knife engaged in the groove of the staff at the uppermost angle of the wound.

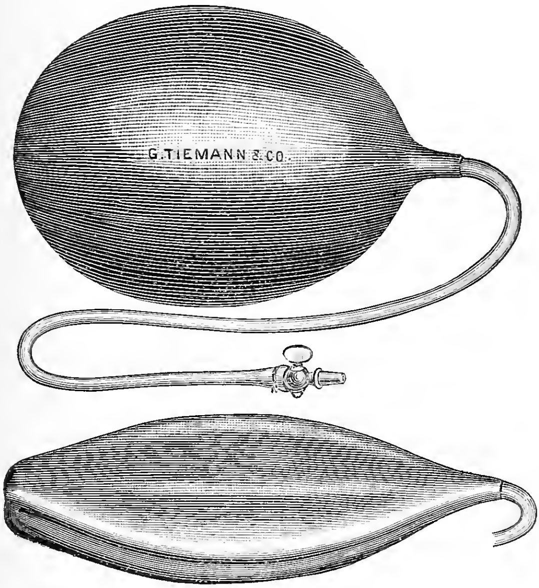
Now, holding the knife at a right angle to the perineum, it is thrust along the groove into the bladder, slightly enlarging the prostatic wound as it is withdrawn. If the operation has been undertaken simply for exploratory purposes, the incision should be confined to the membranous urethra and not open up the prostate. Dilatation of the prostatic urethra and vesical exploration are then effected by the gradual insertion of a finger.

The median operation is only applicable for exploration, drainage, and removal of small tumors, foreign bodies, or stones (under one inch in diameter). Lateral incisions into the prostate and perineum will render the wound more capacious for removal of a calculus.

Supra-pubic Cystotomy (and Lithotomy).

The abdomen is made clean, and the patient placed in the usual position for abdominal section. A rubber bag is inserted into the emptied rectum and distended with ten to fourteen ounces of water. This raises and steadies the bladder. Now the bladder itself is thoroughly washed out with mild (1 to 5000) bichloride solution, and moderately distended with warm water by injection. A tape or rubber band wound around the penis and tied, will prevent its escape by the urethra. As peritoneum does not descend in front of the bladder, it will be observed that by these measures the largest working space between the pubis and peritoneum is thus secured. The organ is now mapped out by percussion, and an incision two to three inches long in the median line is made immediately above the pubic symphysis, and carried down to the linea alba, which is divided to the extent of two inches and held aside with retractors.

Fig. 427.

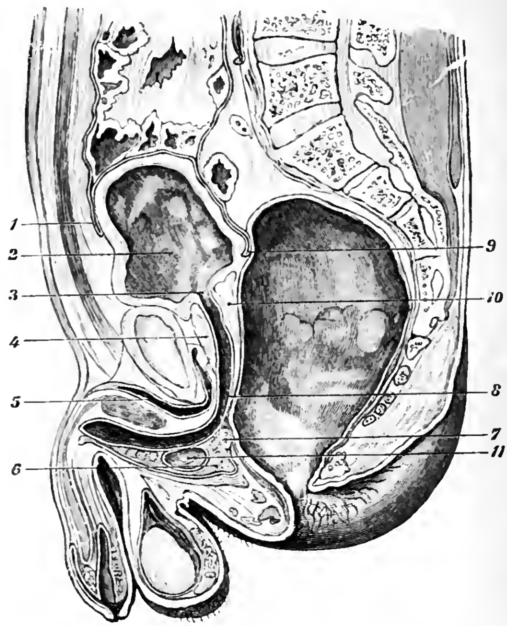


India-rubber bag for distending rectum.

The bladder surface is now exposed freely with the knife-handle. If peritoneum is present it is displaced upward out of harm's way. The vesical wall is now picked up on either side of the median line with catch forceps or sutures, and incised vertically between them in the median line to the extent of three-quarters of an inch. A finger is then inserted and the organ explored. If the incision prove to be insufficiently large through which to deal with a stone, foreign body, or tumor, it should be sufficiently enlarged upward and downward with a hernia knife or scissors, guided by the finger, always, however, keeping clear of peritoneum. If the operation is done to promote continuous drainage, a rubber tube with a crosspiece to

prevent its disappearance should be fastened into the bladder. Otherwise, if the viscus is not septic, sutures should be inserted into the muscular coat one-eighth of an inch apart. The superficial abdominal wound must not be sutured, so that should the bladder stitches give way or leak, the extravasated urine will readily drain away and not be forced into the cellu-

Fig. 428.



Section through a frozen body with the rectum much distended (artificially). 1, peritoneal fold in front of bladder; 2, the bladder; 3, internal orifice of urethra; 4, prostate gland; 5, dorsal vein of penis; 6, bulbous urethra; 7, Cowper's glands; 8, upper end of membranous urethra; 9, recto-vesical fold of peritoneum; 10, prostate gland; 11, abscess in bulbous urethra. (Garson.)

lar tissues. When the bladder is inflamed or otherwise septic no sutures whatever should be introduced, but simply a drain-tube inserted. In either case lightly applied antiseptic dressings should be kept over the wound, and the patient during recovery should lie first on one side and then on the other, to prevent excoriation from urine flowing always over the same surfaces. A foul bladder should be washed out through the wound once or oftener daily. The wound almost invariably—often too soon—promptly closes. *Dangers* comprise: rupture of either rectum or bladder from over-distention, and wounding the peritoneum. Should the latter accident occur the opening in it should be sutured and fastened into the upper angle of the wound, which should be packed with gauze and the bladder not opened until a few days later, unless it is urgent to do so at once.

The Prostate.

Inflammation of the prostate gland (prostatitis) may be acute or chronic.

Acute prostatitis is not common, and usually occurs as a complication of gonorrhœa, but may arise from traumata or the irritation caused by instrumentation, calculi, stricture, or cystitis.

Symptoms.—There is dull bearing-down pain in the perineum and rectum, the parts are sensitive to touch, and micturition, which is increased in frequency, greatly aggravates the distress. Cystitis often complicates. The urine may be blood-tinged. Rectal examination reveals the prostate to be swollen, elastic, and turgid—perhaps to such an extent as to interfere with or prevent micturition. The disease may gradually subside, become chronic, or progress to abscess formation. In the latter case constitutional and local signs of purulent formation arise and fluctuation may be demonstrated by rectal examination. This may open into the urethra, perineum, or other surrounding structures, and perhaps cause intractable fistulas.

Treatment.—Leeches, succeeded by hot fomentations, laxatives, and prompt perineal incision when signs of suppuration or abscess arise.

Chronic prostatitis may follow the acute variety or arise more insidiously from the same causes. Symptoms are identical but of less degree, and much resemble those of vesical or prostatic calculus. There is more or less inflammatory interstitial infiltration and enlargement. Abscess may likewise develop. The patient is often much depressed both mentally and physically.

Treatment.—Remove the cause and restore the impaired health. Counter-irritation by blisters or leeching of the perineum is efficient. So also are cold hip-baths. The prostatic urethra may be cauterized by nitrate of silver. The disease is frequently most intractable, and certain extreme cases may justify perineal cystotomy.

Prostatic Catarrh (Prostatorrhœa).

A very mild form of irritation or inflammation of the gland accompanied by hypersecretion from its gland follicles which appears as a gleety, colorless discharge from the urethra, especially after straining at stool or otherwise, sexual indulgence, or micturition. This escape is apt to have a profoundly depressing effect, as the patient becomes convinced that it is semen that he is losing. From the latter it is differentiated by the microscope, which proves the absence of spermatozoa. Its causes of origin are masturbation, sexual excess, and irritations of the urethra. Removal of causes, improvement of physical condition, laxatives, and perineal counter-irritation by small blisters, together with convincing the patient that his condition is not serious, generally produce a cure. Otherwise the occasional passage of a bougie of large calibre or cauterization of the prostatic urethra (as above) may be required.

Prostatic Tuberculosis.

Prostatic tuberculosis is an uncommon affection and almost always secondary to tuberculosis of the kidney, testicle, or elsewhere. The symptoms correspond with those of chronic inflammation, stone, and cyst-

itis, but usually there is cachexia and unaccountable constitutional disturbance. Implication of the bladder and other contiguous parts speedily results. Generally it is not diagnosable until far advanced. Tubercular abscess may occur at a late stage, when tubercle bacilli can be found in the pus.

Treatment.—The treatment should be directed to general support and early incision into and curetting out of the gland.

Hypertrophy of the Prostate.

Hypertrophy of the prostate is an affection of advanced life, rarely occurring before the fiftieth year. One-third of all men are more or less affected; one-fifth of all to a symptomatic degree. Pathologically the affection is a non-inflammatory increase of the normal glandular and stromal elements of the gland. Both constituents may hypertrophy in equal degree, but more usually the former greatly preponderates. The enlargement may affect the entire organ or only limited portions. Thus may be hypertrophied: one or other of the lateral lobes, both lateral lobes, the middle lobe, or the whole gland. Or even smaller areas may undergo the peculiar change and produce small tumors which, when near the surface, may project into the bladder or urethra. Enlargements of the third or middle lobe and those of the last-mentioned unusual type are alone of surgical importance, as only in the case of these is the vesical orifice or prostatic urethra obstructed and micturition interfered with, and consequent vesical and kidney troubles given rise to. Causes are sometimes to be found in previous urethral, bladder, or prostatic disease, but more often none can be assigned save that of age.

Symptoms.—Unless the middle lobe is involved, or the lateral ones to unusual degree, no symptoms will exist, as a rule. Thus, even great general hypertrophy may remain non-symptomatic, while but slight enlargement of the middle lobe or the projection of a small localized mass into the prostatic urethra may give rise to severe symptoms.

Slight reduction in force and increase in frequency of urination are usually the first signs noted, or a sudden attack of retention following exposure may be the primary indication. Later there develop symptoms of gradually increasing chronic cystitis, burning pain, very frequent and perhaps painful micturition, changes in the urine, pain and sense of tension in the perineum, loss of sleep and exhaustion, and possibly retention continuously or at intervals. Or all of these may suddenly follow exposure when no prostatic trouble had previously been suspected. True incontinence of urine may result from the enlargement of prostate interfering with the action of the vesical sphincter. A crucial symptom of hypertrophy is the finding of more urine in the bladder after its apparent complete emptying by urination. This is due to the enlargement interfering with complete contraction and emptying of the viscus, and soon decomposition of the *residual urine* begins, increases, and develops cystitis; as a result of which stone not uncommonly develops in the bladder or prostatic crypts and greatly complicates the disease. Still later arise symptoms of violent cystitis and kidney involvement. The enlarged gland can often be felt *per rectum*, and, by pressure thereinto, may cause flattening of the stools.

Diagnosis.—In every case of vesical irritation in men over fifty the catheter should be passed after the patient has urinated, and, if residual

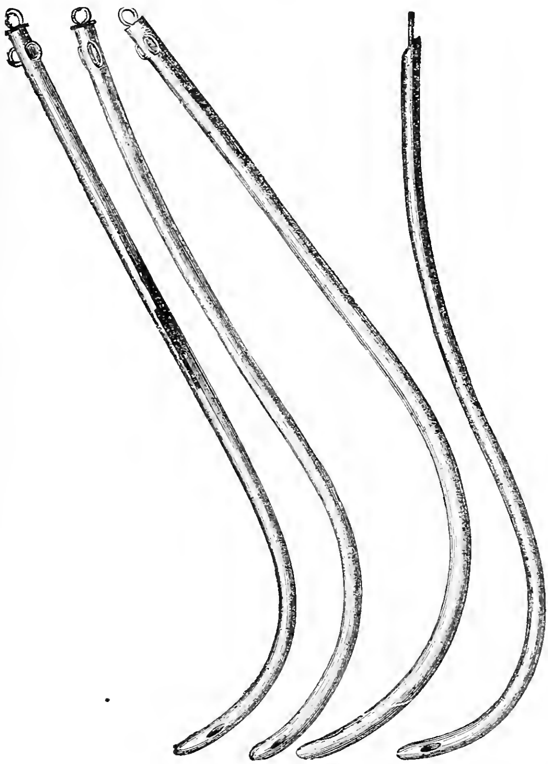
urine is found, a diagnosis of prostatic enlargement may be arrived at. This may be verified by rectal examination, and often also by the difficulty encountered in passing the catheter or other instrument through an irregularly hypertrophied gland. However, by these methods we have only recognized enlargement; its cause may yet be due to tumor or prostatic calculus. The history, symptoms and progress can alone differentiate its exact nature.

Fig. 429.

Rubber catheter.

Treatment.—For the milder degrees nothing more will be required than that the patient shall be provided with and instructed in the use of a soft catheter, with which for the balance of his life he must draw off the residual urine every time after he urinates, in order that the bladder may be kept empty and free of irritation. Even under the most favorable conditions, and particularly after exposure, cystitis or retention, or both, may occur. Retention must be relieved by the passage of a soft or

Fig. 430.



Prostatic catheters.

metallic catheter of large curve (see Fig. 430) to mount over the distorted third lobe. The passage of the latter, when difficult, can be much facilitated by the guidance of a finger in the rectum. If "false passages" have been made by the patient or others in attempting to relieve the accumulation, aspiration for a few days should be practised until the sinuses have a chance to heal. But if acute inflammation or abscess has arisen, it may be wise to at once perform perineal cystotomy.

In all acute complications treatment as for acute prostatitis is appropriate.

Long continuance of prostatic hypertrophy with bladder complications will demand median perineal cystotomy, whereby both pathological processes may at the same time be relieved and often entirely cured. Excision of the obstructing lobe through a supra-pubic incision has been performed with success, but no greater than as above.

Tumors of the Prostate.

Tumors of the prostate are practically limited to carcinoma and sarcoma. Usually they are secondary; most rarely primary. Symptoms at first simulate those of senile hypertrophy, but the growth increases with rapidity and soon gives rise to more or less hemorrhage, often in the intervals between micturition. Treatment can only be palliative. Supra- or infra-pubic cystotomy, with curetting and thorough drainage, or simple lavage of the bladder, often prove of the greatest comfort.

Prostatic Calculi.

Calculi not infrequently develop in the follicles of the prostate, owing to irritation or obstruction thereof by inflammation, tuberculosis or tumors. The stones may be solitary or in great number. Where multiple and in contact, facets mark the points of junction. Symptoms do not differ from those of chronic prostatic and bladder inflammation. Sometimes the catheter may make their presence known by grating as it passes through that portion of the urethra; or they may be discovered by rectal examination. Most frequently their presence is unsuspected until perineal cystotomy is done to relieve bladder symptoms—another advantage to the credit of that operation as compared with the supra-pubic. A fragment which can be recognized may be passed by urethra.

Treatment.—Perineal cystotomy and shelling-out of the calculi by fingers, gouge or forceps.

The Urethra.

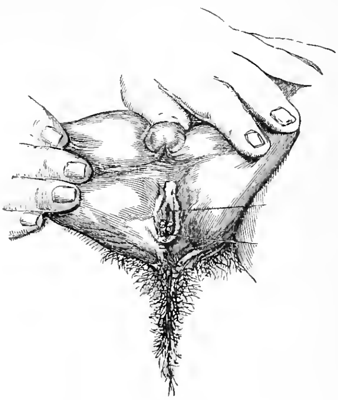
Congenital Malformations.

Congenital malformations of the urethra comprise: partial or entire absence, epispadius, hypospadius, termination in the top of the glans penis, and imperforate, contracted or multiple meatus urinarius.

Epispadias, a defect in the roof of the canal, is generally complete, but may be incomplete. When in conjunction with vesical exstrophy of either sex (and it rarely exists otherwise) the defect always extends from bladder to meatus—the *complete* variety. In males impotence is a usual result.

Treatment.—The treatment of the complete variety is usually unsatisfactory, but cure may be attempted by freshening the edges of the split urethra and suturing thereto, over a catheter, long strips of integument partially separated from the hypogastrium or scrotum. Similar plastic operations succeed better with less extensive defects.

Fig. 431.

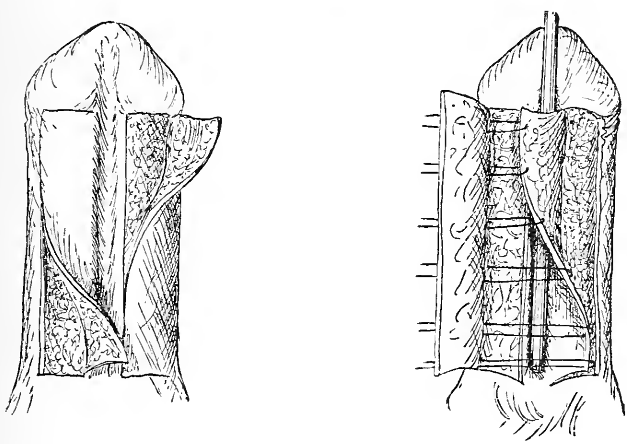


Complete hypospadias. (Smith.)

Hypospadias, defect of the lower portion or floor of the urethra, is very much more common than epispadius, but usually affects a smaller extent of the canal. It is unusual in the female. Complete and extensive posterior hypospadius in the male is associated with cleft scrotum, and results in impotence.

Treatment.—When the openings are close to the meatus often no treatment will be necessary, but when situated further back may be relieved by dissecting flaps from the junction of skin and urethral mucous membrane and suturing them across a small catheter placed in the urethral gutter. Or, these flaps may be split, the lower portions sutured over the catheter, and the upper portions

Fig. 432.



Urethroplasty. (Smith.)

stitched over all. Many other ingenious methods of closing these defects are applicable to certain cases, but cannot be described here.

Prolapse of Urethra.

Prolapse of the urethra occurs only in females; usually in children. A mass of congested urethral mucous membrane with perhaps a portion of that of the bladder protrudes from and more or less obscures the meatus.

When the prolapse is acute these tissues may be inflamed, œdematous, and give rise to retention of urine. The urethra in all cases is much dilated. The *causes* are such as give rise to relaxation, tenesmus, or straining.

Treatment.—Acute varieties may be reduced by continuous gentle pressure and manipulation. If irritative distress attend the chronic or constantly recurring forms (urethrocele) the condition can safely, speedily and permanently be relieved by making a half-inch longitudinal incision from without into the lower urethral wall just behind the meatus. This is carried down until urethral mucous membrane is exposed. A large bougie is then carried into the canal and mucous membrane is pulled through the wound until all prolapsed portions or redundancy disappear. Sutures are then passed through the edges of the wound, including the distal extremities of mucous membrane drawn through it. The membrane external to the stitches is now cut off and the threads tied down firmly.

Urethritis.

Urethritis, or inflammation of the urethra, exists either as a simple (non-contagious) or specific (contagious) disease. Either variety may be acute or chronic.

Simple (or non-specific) urethritis may arise as a consequence of acrid or decomposed urine, menstrual or vaginal discharges, exposure, excessive venery, drugs, alcoholism, seat-worms, instrumentation, or wounds. The *symptoms* are heat and burning pain in the urethra, increased and painful micturition, pouting of the meatus, and later, muco-purulent discharge. *Diagnosis* from the contagious form is generally impossible in the early stages, but the subsequent course and absence of gonococci in the discharge will distinguish the two. Our opinion, for prudential reasons, should be very guarded: always deciding in favor of the simpler disorder when slightest doubt exists, and invariably directing discontinuance of sexual intercourse until cure is complete.

Treatment.—Discover and remove the cause, if it still exists, and treat as if the specific variety. The affection is subject to the same complications as gonorrhœal urethritis, but usually subsides spontaneously in from six to ten days.

Specific or Gonorrhœal Urethritis. (Gonorrhœa.)

An acute, specific, infectious inflammation of the urethra, having a definite period of incubation, and always attended by the presence of gonococci.

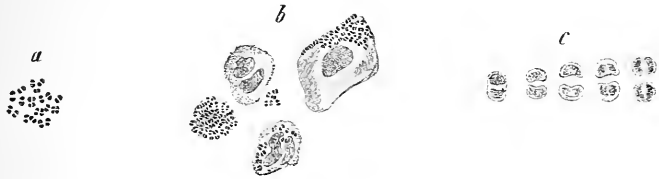
In females urethral gonorrhœa is of trivial importance, existing only as a complication of specific vaginitis.

Cause.—Direct or indirect contagion; usually the former in sexual congress.

Symptoms.—The symptoms depend much upon the extent of urethra involved and are generally first noted on the fourth day—rarely as early as the second or as late as the seventh; when uneasiness and smarting at the meatus and along the urethra, accompanied by slight mucous discharge and scalding urination, are observed. These signs increase in severity for an average of two days, by which time the lips of the meatus are red and much swollen, there is slight œdema of the prepuce, the glans penis is

turgid and glossy, painful erections, especially during sleep, occur, micturition is exceedingly painful, perhaps difficult or impossible, and the discharge changes to a creamy white color and consistency, becomes copious in amount, and may be tinged with blood. Later still the color again changes to a greenish or yellow hue, and, microscopically, will be found composed of pus, mucus, blood, and epithelium containing clusters of gonococci. There is swelling and turgescence of the entire penis, vesical irritation and irritability of all the pelvic organs. The penile lymphatics and inguinal glands may be enlarged.

Fig. 433.



Gonococci. (Bumm.)

a. Cocci from a pure culture.

b. Secretion of gonorrhœal conjunctivitis, showing—epithelial cell covered with cocci; a pus cell with cocci in the protoplasm; a pus cell completely filled with cocci; a free mass of cocci in close proximity to a pus cell.

c. Scheme of development of gonococci.

This condition, as a rule, lasts from ten days to two weeks, after which—depending much upon extent and treatment—the disease gradually subsides and at the end of from four to six weeks, if all goes well, the canal has regained its normal condition, but even under these most favorable circumstances remains more liable to subsequent reinfection than before the primary attack. Much more frequently, however, and especially where the subject has had previous attacks, complete recovery does not take place for months or even years.

Here (*chronic specific* or *gonorrhœal urethritis*, or *gleet*) there persists, in spite of all treatment, for a longer or shorter period, a muco-purulent or clear viscid discharge with slight tenderness of the urethra, which upon any imprudence or exposure may become much aggravated or relapse into subacute gonorrhœa. Chronic persistent urethral discharges usually indicate the presence of granulating patches in the urethra, which almost invariably give rise to stricture later. Long-continued purulent discharge may cause anæmia.

Treatment.—Up to the period of decline—the first week or two—treatment, other than that for acute complications, should consist of perfect rest in bed or upon a sofa, milk or other easily digestible diet, laxatives, perhaps aconite for feverishness, and the ingestion of large amounts of diluents. Nor will more than this be required at any stage if the discharge rapidly diminishes and disappears within five or six weeks. Otherwise, should discharge or other symptoms unduly persist, as is common, sandal-wood oil, cubebs, or copaiba should be administered by mouth, and astringent injections into the canal locally. If old strictures or other complications are present they must be eradicated, for otherwise they may prolong or prevent recovery. The occasional passage of a large bougie, or cauterization of ulcerated portions of the urethra by nitrate-of-silver

stick in a urethral port-caustic, will prove of great advantage in certain inveterate cases of chronic urethritis or gleet.

Fig. 434.

Urethral injection syringe. Natural size.

Complications.—Few cases of gonorrhœa escape without one or more complications. The principal of these are as follow: retention of urine, chordee, acute phimosis or paraphimosis, inflammation or abscess in the prostate or Cowperian glands, epididymitis, orchitis, cystitis, nephritis, inguinal bubo, and pyæmia. Transplantation of infective discharges to other mucous membranes, as the conjunctiva, may occur accidentally and produce very grave complications; also by an ill-understood process of metastasis, gonorrhœal synovitis or arthritis may be established in one or more joints.

The passage of instruments and too early resort to injections are fruitful causes of many of these complications, by carrying the infective material to the deep urethra or bladder.

Cowperitis.

Inflammation of the glands of Cowper is indicated by a sudden or gradual circumscribed swelling on one or both sides of the urethra in the perineum. This may be distinguished from ischio-rectal abscess by the usually unilateral and localized position of the former. It should be treated by poultices until pus is formed, then by prompt and free incision.

Stricture of the Urethra.

Two chief varieties of urethral stricture are recognized, (1) true, or organic, and (2) false, or functional.

1. A permanent organic encroachment upon and diminution of the urethral calibre by contraction of inflammatory products in its walls.

2. Is temporary or intermittent, and results from spasmodic contraction of the involuntary muscles of the urethral wall, usually caused by the presence of true stricture or other irritations at other parts of the canal—hence it is an irritative or reflex phenomenon.

Organic Stricture.

Organic stricture may develop in any portion of the urethra except the prostatic, which is exempt. They are rare before the twenty-fifth year, but common after that age. One or many may be present, either close together or widely separated; more usually there is but one. The sites of constriction in order of relative frequency, are: anterior portion of membranous, posterior portion of penile, and anterior and middle portions of penile urethra. Strictures may be annular, lateral, or tortuous

in relation to the urethral axis; and permeable or impermeable to instruments.

Causes.—Almost all true strictures result from long-continued irritation and inflammation of the urethral mucous membrane and subjacent connective tissues, as a result of specific urethritis. A few are caused by simple urethritis, and fewer still by cicatricial healing of wounds, and ulcerative or necrotic processes.

Pathology.—The pathology of stricture is simply that of inflammation of mucous membrane and peri-urethral tissues, sometimes embracing the deeper tissues of the corpus spongiosum or even the corpora cavernosa. This is succeeded by inflammatory deposit which, later, organizes, contracts to a greater or less degree, and to a proportionate extent diminishes the urethral calibre at that point. Obstructive symptoms and changes in the upper urinary organs then arise.

Symptoms.—With or without a preceding long-continued purulent or gleety discharge, interference with, increased frequency of, and dribbling of the last few drops of urine after micturition, occur. This may simply amount to diminished strength or volume of the stream, gradually increasing until great straining is required to pass the urine, or retention takes place; or after dietetic, alcoholic or sexual excess, or from mere exposure, complete obstruction and consequent retention may suddenly occur, and be the first intimation of the presence of stricture. The obstruction may permit of false incontinence when the intra-vesical tension becomes great, or, if neglected, the urethra may rupture behind the stricture and produce extravasation of urine. Rectal hemorrhoids and prolapse, likewise herniæ, may result from straining incident to partial or often-recurring complete retention. Severe constitutional symptoms result, in neglected cases, from the pathological processes originated in the upper urinary tract as the result of urinary obstruction and decomposition.

Diagnosis.—Presumptive diagnosis may be made from the above symptoms, but can only be verified by instrumental exploration of the urethra.

Exploration of the Urethra.

The patient should urinate and recline upon a flat surface. A dose of quinine (10 grains) should have been administered several hours previously to guard against subsequent "urethral fever." Diagnosis of a marked stricture can be roughly made with an ordinary metal dilating bougie, but

Fig. 435.

Metal bulbous bougie.

Fig. 436.

Rubber bulbous bougie.

accurate and satisfactory exploratory diagnosis can only be conducted with *bulbous* bougies of metal and rubber. If the meatus is contracted, it should be divided. (See Meatomy.) Then, selecting an instrument of

about 25 mm. in diameter (25 French scale) at the bulb, the penis is put slightly upon the stretch, and the bulb passed down the urethra until obstruction is encountered or the bladder entered. If the former obstruct the instrument, smaller and smaller bulbs are successively tried until one can be gently pushed through the obstruction and into the bladder. Upon now slowly withdrawing the explorer, resistance will be met so soon as the shoulder of the bulb engages in the constriction. A bend or mark is then made upon the instrument at the meatus. Traction is then made until resistance ceases, and another mark is made. Thus we have diagnosed a stricture, its calibre, situation, and, by the distance between the marks, its extent. If multiple strictures are present, they are consecutively discovered, located, and measured as the instrument is withdrawn. If the smallest bulb will not pass the obstruction, we can only thus diagnosticate the presence of stricture of small calibre, beginning at a certain distance from the meatus.

Care must be taken in exploring for stricture not to mistake a slight resistance or hitch which is invariably imparted to the instrument as the bulb passes from the prostatic to the membranous urethra, at which junction the bulb catches upon the posterior layer of the triangular ligament, which at that point closely invests and fixes the urethra. Nor must a spasmodic contraction of the compressor urethræ muscle (*false stricture*) be mistaken for or confounded with organic stenosis. The former may be recognized by its uniformity, smoothness, and, perhaps, intermittent tension.

TREATMENT.—Strictures are treated either by intermittent, continuous, or forcible rapid dilatation; by division by the knife, from within outward (internal urethrotomy), or from without inward (external urethrotomy), or by combinations of any of these methods.

Dilatation of the Urethra.

Intermittent dilatation is applicable to and most successful in by far the largest proportion of cases met with, particularly those of recent origin and annular shape.

Preserving the usual precautions, a steel bougie of diameter equivalent to that of the stricture is warmed, oiled, and gently passed through the stricture. Then an instrument two sizes larger is introduced, and finally one yet a size larger, which is kept in for five minutes before withdrawal. If no complications follow, this should be repeated, beginning with the second largest size last used, every three to six days until the stricture becomes dilated to the normal calibre of the urethra. The latter can be ascertained approximately by measuring the penile circumference, for, as pointed out by Otis, the average measurement of the flaccid penis is three inches, and the diameter of the urethra 32 mm., and that for every quarter inch increase or decrease in the circumference of the penis a relative difference of 2 mm. exists in the urethral calibre, which amount should be added to or subtracted from the size of the normal urethra to ascertain the normal calibre of any individual case.

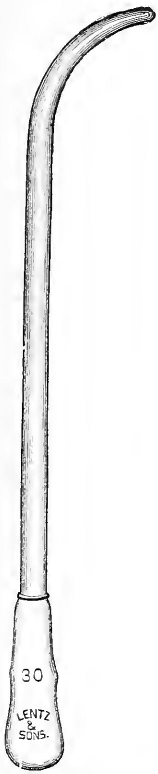
After full dilatation has thus been secured and maintained for a few weeks, the patient should be taught how to pass the instrument, and be provided with a full-sized one of his own, which he must pass monthly, or oftener if need be, for the balance of his life.

If upon each successive passage of the instrument great irritation or

early and firm recontraction takes place, longer intervals between dilatations must be allowed to pass, or other methods of treatment employed. General anæsthesia is but rarely necessary. Nitrous oxide gas may be employed. Cocaine renders the operation almost free from pain, but has more than once caused death when thus used.

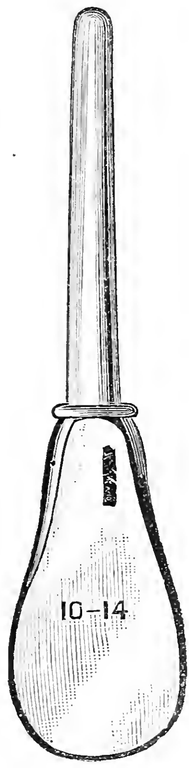
Continuous dilatation is employed where the stricture is only permeable by very small instruments which cannot be followed up by larger ones; in certain cases associated with acute or chronic retention of urine; and where a speedy full dilatation is desired.

Fig. 437.



Type of metal dilating bougie.

Fig. 438.



Type of bougie for dilating strictures of the meatus.

The method is applied by passing an instrument two sizes smaller than the largest which the stricture will admit, and tying it in the urethra for a number of days. If the constriction will admit even a small instrument readily this can be carried out easily enough, but assuming that the stricture is tortuous and of very small calibre, we would proceed as follows: Anæsthesia having been induced, if necessary, a fine gum catheter is carried down to the stricture and manœuvred through it if possible. If this pass, well and good: it should be tied in by means of tapes running to a piece of plaster encircling the penis behind the glans, or to a bandage encircling the waist. But failing to thus pass the stricture, the

Fig. 439.

Filiform whalebone bougies.

urethra should be filled with filiform whalebone bougies having vari-shaped extremities, and most gently attempting to pass each one in turn until finally one engages in and passes the stricture, when it should be fastened in after its fellows have been removed. This also failing after a reasonable effort, the patient should be put to bed, and in from twelve to twenty-four hours another attempt made. But if acute retention exists, aspiration or external perineal urethrotomy should be immediately resorted to.

After the instrument has remained tied-in for a day or two—the urine meanwhile constantly trickling through or alongside of it—it should be daily removed and cleansed or replaced by one of larger size, but never so large that it does not fit the constriction very loosely, for otherwise great irritation will be set up and more harm than good accomplished. Under influence of the retained instrument the most callous and obstinate strictures will completely dilate and melt away in from a few days to two weeks, after which event intermittent dilatation should be started and persistently carried out.

In all probability the softening, dilatation or "melting" of strictures under this method is not due to the exertion of pressure, but to some unknown influence exerted by the presence of a non-irritating foreign substance in the urethra.

Forcible (immediate or rapid) dilatation is used to produce immediate divulsion of a narrow or tortuous stricture to permit easy application of intermittent dilatation subsequently.

For this purpose a silver catheter of very small calibre, eighteen inches long, is introduced into the bladder, and over it are slid, one after another, dilating tubes of increasing size until full dilatation has been attained.

Internal urethrotomy is employed in certain cases where the stricture is extremely callous, contracts firmly after each dilatation, or is very persistent. Cases in which this proceeding is indicated are not common. The stricture must previously be dilated sufficiently to admit the urethrotome.

External urethrotomy is applicable to a class of cases presenting very dense or impermeable stenosis, and especially when complicated by fistulæ or rupture of the urethra; where all other methods have failed to give a temporary or permanent result; or in which cystitis, prostatic disease, or stone coexist, and both diseases can be cured by this operation. No matter where situated or how bad, all strictures melt down, become permeable and can easily be treated subsequently by intermittent dilatation after this operation has been performed.

Urethral Fever.

Urethral fever is the name usually applied to a condition of pyrexia or hyperpyrexia, accompanied by more or less severe chills, which is apt to supervene upon perhaps even the slightest instrumental interference with

or injuries of the urethra. It may develop immediately after the passage of a sound or what not, but more usually after the lapse of several hours. The causes are usually reflex nervous phenomena, but may be septic absorption on occasion.

TREATMENT.—The treatment is: warmth after operations, quinine, anodynes, removal of any instrument from the urethra or bladder, and suspension of all surgical interference for the time being.

URETHRAL FISTULÆ.

Urethral fistulæ, as a rule, result from abscesses originating in the glands thereof in connection with stricture which rupture externally. Also fistulæ may arise from non-closure of operation or accidental wounds of the canal and from ulceration incident to stones or foreign bodies. One or many may be present. They may originate from any portion of the organ, but most usually start in the scrotal or perineal divisions, are multiple, and burrow far before opening externally, as upon the groin, thigh, perineum, scrotum, etc., or into the rectum.

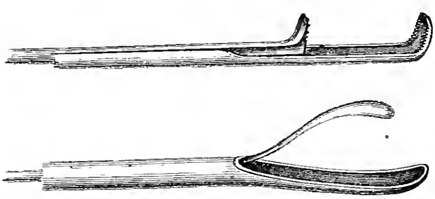
TREATMENT.—Removal of the cause will usually be followed by prompt closure, otherwise treat as described under Hypospadias if confined to the penis, or by freely slitting up the sinus to its point of origin from the urethra and packing or suturing the refreshed margins of the wound, if opening upon the perineum or scrotum.

CALCULI AND FOREIGN BODIES.

Small calculi lodged or developed in the urethra, and foreign bodies introduced from without, occasionally demand removal.

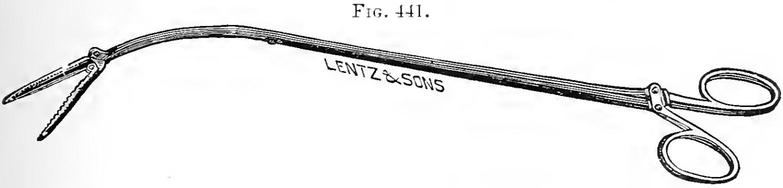
DIAGNOSIS.—The diagnosis is usually palpable to touch, but is confirmed by the urinary obstruction and by passing a sound.

FIG. 440.



Urethral foreign-body scoops.

FIG. 441.



Urethral foreign-body forceps.

TREATMENT.—Elongated bodies can generally be caught and removed by urethral forceps; round bodies by a scoop. Long pins can often be extracted by forcing the point through the penis, reversing its direction,

and pushing the head toward the meatus. If stricture is present in front of the calculus it must be dilated at once, or in this or any other difficult case direct incision upon the foreign substance through the lower urethral wall may be made, removal effected, and the wound allowed to heal by granulation.

Tumors.

Vascular, fibromatous, neuro-fibromatous, papillomatous, and myxomatous neoplasms occasionally develop from the walls of the urethra and project into its cavity. Cancer and tubercle are almost never here located as primary growths.

Symptoms.—These are made up principally by those of obstruction, localized pain, and, perhaps, hemorrhage. The growths may usually be recognized by sight, palpation through the urethral walls, or by the bulbous bougie.

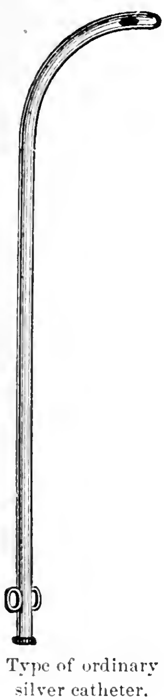
Treatment.—The growths may be removed by forceps or snood if near the meatus; otherwise by an incision through the urethral floor.

Fibro-vascular Tumors.

Fibro-vascular tumors at the orifice of the female urethra (urethral caruncle or hemorrhoids) are quite common, exceedingly painful upon motion, micturition, or sexual intercourse. They are easy to diagnose, as, in conjunction with the above symptoms, there are seen at or surrounding the meatus, one or more intensely red and sensitive hemorrhoidal tumors of minute size.

Treatment.—Pick them up with a forceps or tenaculum, snip the pedicle with scissors, and touch the wound, which will bleed freely, with nitric acid or the cautery, being careful not to let the former agent spread on to contiguous parts.

Fig. 442.



Type of ordinary silver catheter.

Injuries of the Urethra.

Injuries of the urethra result from accidental, self-inflicted, and surgical traumata. Severe contusions and lacerations are apt to be followed by hemorrhage, extravasation of urine, inflammation, sloughing, and the subsequent formation of cicatricial or traumatic stricture. Rupture of the urethra may be occasioned by retention, pressure, or by falls upon the perineum, as astride a plank. In either case the injury is promptly followed by urinary extravasation.

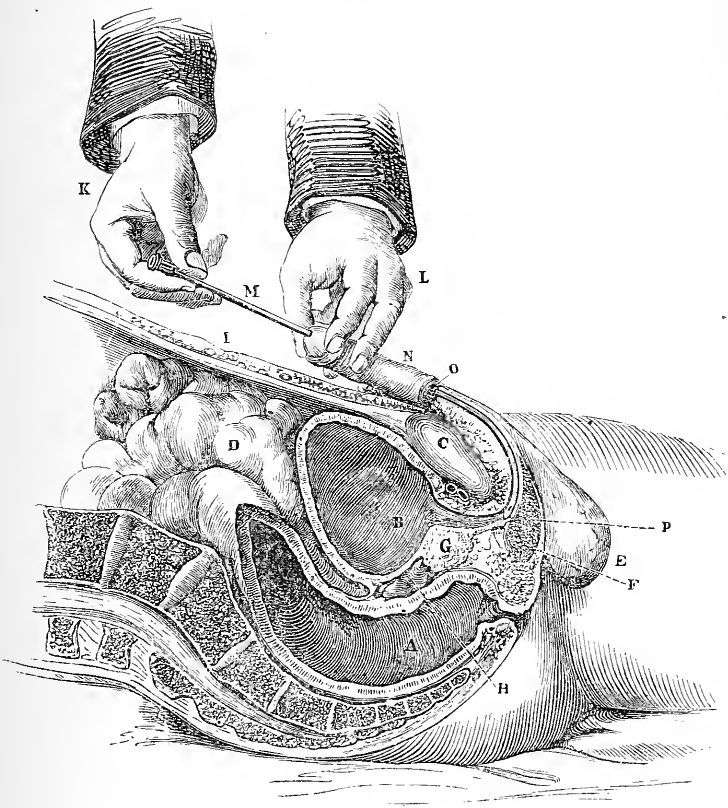
Treatment.—Most injuries of the urethra require but treatment upon general principles. When rupture or other wound gives rise to extravasation or retention of urine, and a catheter cannot be passed, immediate resort to perineal cystotomy must be made, all infiltrated tissues slit up, and later, when all swelling has disappeared, a catheter is carried through the entire urethra at frequent intervals as the wound heals. Subsequently, a metal bougie should be passed as long as there is any sign of constriction.

Operations upon the Urethra.

Catheterization.

Catheterization can only be learned by practice, yet a few guiding directions may be laid down. Observe that the catheter is absolutely clean, strong, and well oiled. The patient occupies a recumbent position with the thighs separated. With the thumb and index finger of one hand grasp the head of the penis gently and turn the organ up over the pubis toward the abdominal wall. Then, with the other hand, insert the instrument into the meatus and along the urethra until the point reaches the perineal region, when, with the utmost gentleness, the handle is carried in a vertical arc toward the patient's feet until the bladder is entered and urine flows. But if any resistance is felt in the deep urethra a finger should be inserted into the rectum to act as a guide in carrying the instrument through the deep urethra and prostate.

Fig. 443.



Introduction of the catheter. (Voillemier.)

Catheterization of the Female.

If the sight can be employed there will be no difficulty in finding the meatus and still less in passing the catheter. But as this means is usually inadmissible, the procedure may be accomplished as follows: Select a straight gum or metal instrument. Insert an index finger into the vagina and hold it, palmar surface up, rather firmly against the upper vaginal wall in the median line. Now, with the disengaged hand, carry the catheter along the flexor surface of the inserted finger and it will almost invariably enter the urethra.

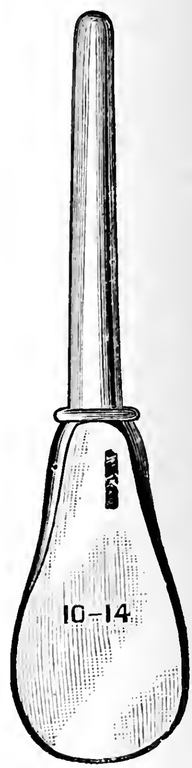
Internal Urethrotomy.

The patient having been prepared as for other urethral operations, and the urethra suitably dilated, if necessary, the urethrotome is marked at a point showing the distance to the posterior extremity of the stricture by a

FIG. 444.

Urethrotome.

FIG. 445.



Type of dilating bougie for female urethra.

rubber band, and inserted until the knife is one-fourth of an inch behind the constriction. The canal and stricture are then put upon a moderate stretch by screwing apart the dilating blades of the instrument, and the knife blade is protruded one-eighth of an inch and drawn through the entire length of constriction. The knife is then pushed back into its sheath, the dilating blades half-closed (not wholly closed, for fear of catching mucous membrane), and the instrument withdrawn.

If the stricture is quite thick, several incisions should be made in the same line after each time separating the dilating blades to a greater extent, until the stricture is cut to correspond with the normal urethral calibre. All cuts should be made in the roof of the urethra except in the external one and a half inches of the canal, where they should be made in the floor. Immediately after division, a full-sized bougie should be passed, and intermittent dilatation kept up for an indefinite time. Hemorrhage may follow the operation, but it is usually slight. In other case, a catheter should be passed, and a bunch of cotton bound more or less firmly about the penis.

External Urethrotomy.

When a grooved staff or other instrument can be inserted into the bladder, this operation coincides almost precisely with median perineal cystotomy. But if the stricture is impermeable a straight staff is carried along the canal as far as it will go. Incision is then made in the perineal raphé until the point of the staff is come upon and healthy urethra divided. Each side of the split urethra is sutured and held by a silk thread. Careful dissection is then made in the direction of the prostatic urethra, a finger in the rectum serving as a partial guide, while at the same time guarding that cavity, until the urethra, usually much dilated and of consequence more readily found, is opened up. This event will be announced by a gush of urine. Any well-marked cicatricial tissue is now trimmed away, and the wound left to granulate and cicatrize. The passage of bougies should be started a few days later.

Dilatation of the Female Urethra.

Dilatation of the female urethra is accomplished by the introduction thereinto of increasing sizes of slightly conical, short, straight bougies or plugs, Fig. 445, or by inserting one finger after another, beginning with the fourth and ending with the index. Permanent paralysis may result from extreme hyper-dilatation. Temporary incontinence usually follows even slight dilatation.

CHAPTER XXIV.

DISEASES AND INJURIES OF THE REPRODUCTIVE ORGANS.

THE SCROTUM.

In cases of complete hypospadias the scrotum is split into two halves, each containing a testicle, or, as likely as not, one or both of these latter organs may be undescended. Such cases, together with fissure or absence of the penis, give rise to most instances of so-called hermaphrodism.

The veins coursing through the scrotal walls occasionally become varicose to an extreme degree. When the annoyance or pain arising therefrom is not checked by wearing a suspensory, the vessels may be ligated in several places or excised. Where great redundancy becomes a source of discomfort, large oval portions of the scrotal integument may be cut away and the wound-edges closely sutured without drainage.

Elephantiasis.

Elephantiasis is an unusual disease of the scrotum in this latitude, consisting of an enormous hypertrophy of the skin and connective tissues. The penis is almost always similarly involved. Febrile disturbance is marked in the early stages, but lessens as the hypertrophy and concomitant debility increase.

Treatment.—Certain favorable cases may be cured by excision, even if the proportions of the growth are enormous. For this purpose the mass is elevated and constricted at its base with a rubber band or other tourniquet. The penis and testes are then exposed by deep incisions and dissected from the mass, which is then cut away at its base. The wound, after all bleeding points have been secured, is dressed antiseptically and allowed to heal by cicatrization.

Lymph Scrotum.

Lymph scrotum is a variety of hypertrophy due to lymphatic obstruction caused by the presence of filaria sanguinis hominis in the higher lymph vessels. Attempts to remove the worm are alone admissible in the way of treatment.

Epithelioma.

Epithelioma (chimney-sweep's cancer) is prone to develop upon the scrotum of those of any age who work amidst soot. Otherwise it is a rare affection. The growth presents the same characteristics as do epitheliomata elsewhere situated.

Treatment.—Excise the mass and surrounding tissues embracing the entire thickness of the scrotal wall. Suture the wound, if small, otherwise allow it to granulate under antiseptic protection.

Contusions of Scrotum.

Contusions usually give rise to extensive blood extravasations between the layers of the scrotum, with great discoloration of the surface. Abscess or sloughing may result.

Wounds.

Wounds are treated upon the general principles of wound treatment already laid down. Should the testicle prolapse it should be cleansed, returned to position, and the skin brought together over it, leaving in a small drain-tube.

THE TUNICA VAGINALIS.

Hydrocele.

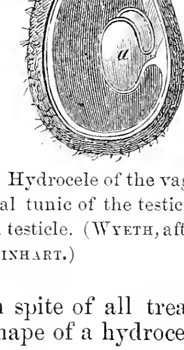
A serous effusion into the peritoneal sheath of the testicle. The affection may be (1) congenital or (2) acquired.

1. *Congenital Hydrocele* is almost always found in young children, and is due to non-closure of the communication of the tunica vaginalis with the peritoneal cavity. Congenital or early acquired hernia frequently complicates the defect. There is fluid in the sheath which responds to the light and succussion tests, disappears upon pressure and lying down, and reappears upon removing pressure or standing up.

TREATMENT.—Spontaneous cure usually results by closure of the peritoneal communication at the neck of the sac. A truss should be worn for hernial complication. Do not attempt tapping or injection in this variety of hydrocele.

2. *Acquired hydrocele* is quite common in childhood and after middle life. One or both sides may be involved—usually but one. Some form of inflammation is generally the causative factor. The cyst may contain from an ounce up to a quart or more of fluid. This fluid is straw-colored, clear, has a specific gravity of about 1030, coagulates upon exposure or boiling, and is made up almost wholly of albumen. If the result of acute inflammation the serum may be turbid and perhaps contain blood and pus corpuscles; when milky the color is due to the presence of spermatozoa, which have come from the testicle as a result of rupture of a cyst of the gland or epididymis into the vaginal tunic. Cholesterine crystals commonly are present and float upon the surface of the liquid.

FIG. 446.

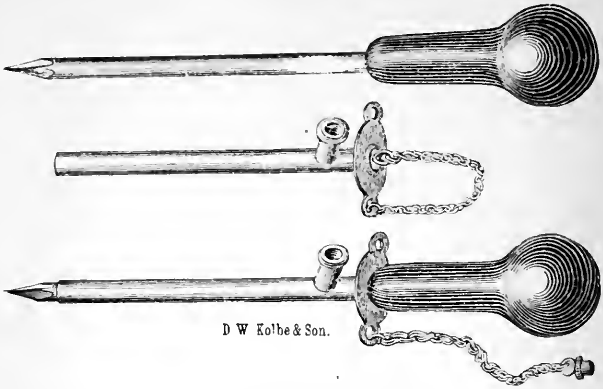


Hydrocele of the vaginal tunic of the testicle. *a*. testicle. (WYETH, after LINHART.)

In recent cases little or no change can be observed in the tunica vaginalis, but in those of long standing and especially where many tappings have been made, the membrane is vascular, much thickened, and excessively tough. Either lying loose in the sac, attached to its walls, or even pediculated, are sometimes found pea-sized or larger dense fibrinous bodies; cases presenting which are apt to suffer much pain or neuralgia and to persistently relapse in spite of all treatment until the bodies are found and removed. The shape of a hydrocele

is usually pyriform but adhesions in the sac may cause it to assume other shapes or even divide it into several separate cysts.

Fig. 447.



Trocar for tapping hydrocele.

Symptoms.—Swelling of the scrotum, which begins below; a sense of weight and occasional dragging pain therein. Tension is not apparent at first but soon develops and becomes more and more marked, while the tumor assumes a characteristic pyriform shape. If very large—especially when double—the penis is entirely retracted into the cyst wall and upon micturition the urine runs down over the scrotum. Fluctuation is marked and the tumor is seen to be translucent when a light is held on one side of the swelling and looked at from the other, while a hand shuts off all extraneous light from the observer's eye. It cannot be reduced to the abdominal cavity and gives no impulse when the patient coughs. Occasionally it is impossible to distinguish clouded or opaque hydroceles from tumors of the testicle until incision is made.

Fig. 448.

Tapping a hydrocele. (Bryant.)

Treatment may be (1) palliative, or (2) radical.

1. *Tapping.* Cleanse the parts and by the light test locate the position of the testicle. Grasp the scrotum and make it tense while a clean trocar of medium size is plunged into the cyst so as to avoid scrotal veins and the testicle. Withdraw the pin and allow the contents to drain away through the canula. Subsequently a small antiseptic dressing retained by an adhesive strap will be required for a few days.

2. *Radical treatment* includes: (*a*) tapping and injection and (*b*) incision and drainage.

a. Injection is made by throwing into the sac through the canula, after the contents have been withdrawn, from one to four drachms of pure tincture of iodine or five to ten minims of liquefied carbolic acid crystals.

These irritative agents—when carried into all portions of the sac—produce inflammation and subsequent obliteration of the cyst cavity by universal adhesion of its apposing walls. It is very generally successful unless the fibrous bodies above mentioned happen to be present, when failure will usually ensue; also it is quite safe and free from unpleasant consequences. The attendant pain is not severe. The patient should recline in bed or upon a sofa for a couple of days.

b. Incision and drainage, as a rule, prove most effectual, and are equally safe if antiseptic methods are pursued. A two-inch incision is made through the scrotum into the sac. Fibrous bodies are then carefully searched for, and removed if present. The sac is wiped over with tincture of iodine, a small drain-tube inserted, the wound sutured about its orifice, and an antiseptic dressing applied. The tube should be removed in a week. This method must always be adopted when inflammatory complications exist.

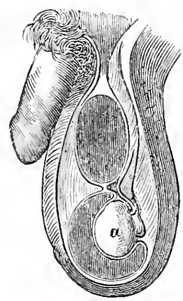
Hydrocele of the Spermatic Cord.

A collection of serous fluid in an unobliterated portion of the peritoneal sheath of the cord.

SYMPTOMS.—A globular or oval, tense, fluctuating, irreducible, freely movable tumor is located at some point upon the spermatic cord external to the internal abdominal ring.

TREATMENT.—The treatment is as for vaginal hydrocele, but the operator should make certain that no communication with the abdominal cavity exists before applying radical measures.

FIG. 449.



Encysted hydrocele of the cord. *a.* testicle. (WYETH.)

Hydrocele in the Female.

Hydrocele in the female affects analogous parts, and in many respects resembles hydrocele of the cord in the male. It consists of a localized collection of serous fluid in some portion of the serous tunic of the round ligament as it courses through the inguinal canal to be inserted into the cellular tissue of the greater labium.

It must be differentiated from hernia, cysts, and varicosities of the labium. Treatment is identical with that of hydrocele of the spermatic cord.

Hematocele of the Tunica Vaginalis.

Effusion of blood into the tunica vaginalis. It may complicate any form of hydrocele, or exist independently. The usual cause is contusing violence, injury by the trocar point, tearing of adhesions, or rupture of a vein.

SYMPTOMS.—A heavy, painful, pyriform (base downward) tumor distends the tunic, is fluctuating, flat upon percussion, while the scrotum is apt to be tense, livid, and ramified by distended tortuous veins. The testicle can be outlined below and behind. Pain later disappears, but only to return should inflammatory complication arise. The tumor is opaque to the light test, and does not transmit impulses when the patient coughs. The blood may be absorbed, break down into a viscid consist-

ency, or, rarely, abscess may form. Calcification of the mass has been observed.

Treatment.—Rest in bed, elevation of the scrotum, and cold affusions thereto; leeches in the line of the cord are applicable to the acute or formative stages. If at a later time resorption does not take place or inflammation arises, incision, turning out the clots, and drainage as in hydrocele should be resorted to.

The Spermatic Veins.

Varicocele.

Varicosity of the spermatic and pampiniform veins of the spermatic cord.

This condition is rare after the fiftieth year; early manhood and the prime of life are the chief periods of origin. Occasionally the disease is double or upon the right side, but in the vast majority of cases the left side, and it alone, is involved. The theoretical explanations given to this fact are: the left spermatic vein is longer than the right, supplies the larger testicle, opens into the renal vein at right angles, has no valve at its renal outlet, and lies close upon the sigmoid flexure of the rectum, and is thereby exposed to pressure from distention thereof. Great exertion, strains, constipation, venery, pressure upon the cord of trusses, and relaxed scrotum act as exciting causes.

Symptoms.—When the cord is searched for in its usual position a mass much resembling a bunch of worms is felt; it is compressible, can be emptied by pressure or upon the patient's lying down, returns upon rising, and greatly distends when he coughs or strains. In the mass can be felt and isolated the whipcord or wire-like vas deferens. Perhaps the tortuous veins can be seen distending the scrotum. Pain of a dragging, dull, distressing, unnerving character, is usually present, and increased—as is the varicosity—in warm weather, when the scrotum and other tissues are more lax.

From malnutrition incident to impeded return circulation, the testicle is apt to atrophy more or less, also to become tender and sensitive. Grave mental distress—principally from fear of sterility—often accompanies the disease.

Treatment.—In very many cases comparative relief and comfort can be secured by regulation of diet and bowels, judicious exercise, tonics, cold bathing and hip baths, and wearing a well-fitting suspensory bandage or bag. Where such measures fail, ligation of the veins *en masse* should be performed. This operation invariably gives immediate and permanent relief and does not interfere with the nutrition or activity of the testicle.

Ligation of the Spermatic Veins.

The scrotum and surroundings having been rendered aseptic and shaved, a vertical incision down to the veins, two to two and a half inches long, is made upon the antero-external aspect of the scrotum. The vas deferens is now recognized by its wire-like feel when rolled between the fingers and isolated behind the thumb and index finger, while the veins are all kept in front. A strong catgut ligature is now passed with an aneurism needle between the veins and fingers, separating them from the vas at the upper-

most exposed portion, and tied tightly about the varicose mass. The same is then repeated just above the epididymis, and a section of the mass cut out between, leaving a good-sized button of tissue at each point of ligation. A small catgut or rubber drain is inserted, the wound sutured and dressed antiseptically. The patient must be kept upon his back in bed for a week subsequently.

The Testicle.

Congenital Abnormalities.

One or both testicles may be absent from their normal position, the scrotum, incident to non-descent from the abdominal cavity, retention in the inguinal canal, or entire want of development. The vas deferens or epididymis may be absent or unconnected with the gland.

Malposition of the Testicle.

This is not a very uncommon anomaly. One or both may be affected, but more usually only one, and that one the left. The organ may be retained (1) in the abdominal cavity, (2) the inguinal canal, (3) situated just without the external abdominal ring, or, very rarely, (4) in the perineum.

In all positions external to the internal ring, the gland is excessively liable to injury and inflammation because of its fixed and constricted position, and, as a rule, is imperfectly developed or rudimentary.

Causes.—The causes of malposition are: narrowing of the inguinal rings or of the canal, premature enlargement of the organ, adhesions acquired in the abdomen or in the descent, a short spermatic cord, and, possibly, paralysis of the gubernaculum testis.

Treatment.—No treatment is applicable to testes remaining in the abdominal cavity. When otherwise situated attempts may be made to manipulate the organ into the scrotum or to suture it to the bottom thereof, and afterward apply a truss to the external ring to prevent its return or the development of hernia. If the gland becomes subject to inflammation or is otherwise troublesome, it should be promptly excised.

Epididymitis.

Epididymitis, or inflammation of the epididymis, is the most common inflammatory affection of the testicle. It may be associated with orchitis, but much more usually is independent. It may be acute or chronic, single or double.

Causes.—Almost all cases are caused by septic (gonorrhœal, etc.) material travelling along the vas deferens from the deep urethra; but may follow instrumentation or injury, or arise in the course of syphilis.

Symptoms.—Rather suddenly and with marked febrile reaction the epididymis becomes swollen, painful, and exquisitely sensitive to pressure. The pain is of a sickening, dragging, throbbing variety, and is in part referred to the loins and inguinal regions or thighs. The spermatic cord is likewise enlarged and sensitive. The tumefaction is confined to that portion of the testicle corresponding to the position and outlines of the epididymis, which becomes hard, tense, and heavy. Hydrocele may complicate the affection as well as its diagnosis. If gonorrhœa has been

the cause, urethral discharge greatly diminishes or disappears temporarily. Abscess is an unusual termination.

In the course of a week acute symptoms begin to subside, but swelling, some pain, and tenderness remain for weeks, months, or perhaps permanently. When all symptoms have disappeared the testicle will usually remain decreased in size and sterile. Double epididymitis may produce complete sterility.

Treatment.—The treatment should consist of rest in bed, elevation of and cold affusions to the scrotum, leeches along the spermatic cord, laxatives, restricted diet, and opium and belladonna suppositories for pain. Abscesses, when they arise, should be promptly opened.

Fig. 450.

Method of strapping testicle. (Smith.)

To eradicate the swelling and hardness of the organ, which usually persist for a long time after the disappearance of acute symptoms, strapping of the parts by strips of adhesive plaster or a long, thin rubber bandage applied to the scrotum should be resorted to, and the whole supported by a snugly-fitting suspensory bag.

Orchitis.

Inflammation of the secreting or gland substance of the testicle. This is a less frequent affection than epididymitis, but often exists in conjunction therewith. One or both testes may be attacked.

Causes.—The causes, outside of those of epididymitis, are almost limited to injuries and metastasis in parotitis and pyemia.

Symptoms.—The symptoms are mainly those of inflammation of the epididymis, but the organ is heavier and assumes a more oval outline, corresponding to the shape of the gland. The pain is more nauseating and there is an almost intolerable sense of dragging weight. Later the scrotum becomes tense and swollen, and not infrequently abscess forms. The acute stage likewise lasts about a week, but if suppuration does not occur, the gland then speedily resolves to a normal condition. Sterility is an even more common sequence here than in epididymitis.

Treatment.—The treatment likewise corresponds with that of the epididymal inflammation. When abscess forms and opens or is incised the mass of glandular structure is apt to slough out as a whole. Chronic inflammation, or continued purulent discharge from the testicle, may demand its ablation.

Tuberculosis of the Testicle.

Tuberculosis of the testicle affects generally but one side, and in those of tuberculous tendency, or as a complication of tuberculosis elsewhere in the body; beginning as a rule in the epididymis, and subsequently involving the gland proper.

Symptoms.—The epididymis becomes tumefied, but without marked pain or tenderness, and later the testicle likewise enlarges, suppuration with abscess formation supervenes and constitutional disturbance may or

may not arise. Hydrocele may complicate. The gland may slough away after opening of the abscess, but in any case obstinate fistulæ with purulent discharge are apt to follow the evacuation of these abscesses. It is often absolutely impossible to diagnose tuberculosis, even at late stages, from tumors of the testicle before incision is made.

Treatment.—Excision of the affected organ is alone admissible.

Tumors of the Testicle.

Sarcoma is the most common primary tumor of the testicle met with, but carcinoma, adenoma, chondroma, dermoid and other cysts, and teratoma are of rare occurrence in this locality.

Sarcoma is usually small in size and of the round-celled variety, but if large more usually is cystic and of spindle-cell construction.

Carcinoma occurs only in those advanced in life and is always encephaloid in type.

Symptoms.—The symptoms of these two classes of tumors are almost identical. The organ becomes tense, firm, heavy, globose, does not expand upon coughing, is flat upon percussion, and is opaque to the light test. The cord may also be more or less involved. Sarcoma in late stages often assumes huge proportions and remains smooth and regular in contour. The skin may slough over portions of the growth, but necrosis is limited to the integument. On the other hand, carcinoma becomes nodular in late stages and tends to involve every adjacent structure, while sloughing extends deeply into the interior of the growth. Excision of the testicle and growth should be performed at as early a stage as possible. Metastasis and recurrence in the cord or elsewhere are usual.

Injuries of the Testicle.

Severe contusions and wounds of the testicle are accompanied by an amount of shock totally disproportionate to the injury, owing to the great sympathetic distribution to the gland. Profound syncope or even death may be caused thereby. Inflammation and abscesses commonly follow these injuries.

Excision of the Testicle (Castration).

The parts having been properly cleansed and shaved, a vertical incision is made from end to end through the antero-lateral portion of the scrotum until testicle and cord are equally exposed in the wound. The organ is now freed from its cellular attachments and lifted, without great traction upon the cord, from the wound. A double strong catgut ligature is then passed by a blunt needle through the middle of the cord well above the testicle or tumor, and each half firmly tied off. The cord below the ligature is now severed and the testicle removed. If the pedicle is very large it should be tied off in small sections in similar manner. If subsequent hemorrhage is feared the stump may be transfixed and held in the wound by a steel pin. The wound is sutured, drained, and dressed in the usual manner.

Spermatorrhœa.

A functional disease involving involuntary discharges of spermatic fluid with slight or no sexual pleasure or orgasm. It must not be con-

founded with mucous or gleety discharges from the urethra, with the natural nocturnal emissions of continent health, or those produced by strain, as at stool, forcing semen from overcharged seminal vesicles. The real disease is dependent usually upon excessive irritability of the prostatic urethra, brought about by venereal abuse, and is generally coincident with a peculiar mental condition, either as cause or effect, together with great excitability of and lack of inhibitory power in the venereal centres of the brain and cord; or it may be but a symptom of grave structural changes in the central nervous system.

Treatment.—Treatment should be directed to improving the general, physical, and mental condition, and to removal of the cause.

The Penis.

Congenital Abnormalities.

The penis may be absent, double, or tied down to the scrotum by a web of skin or broad adhesion. Also portions may be absent or imperfectly developed and produce, more especially during erection, curvations of various degree and direction. A very short frenum may likewise produce curvation. Phimosis is frequently congenital. *Acquired* deformities result usually from sloughing, incident to injuries and chancroidal sores. Many cases of each variety above mentioned are capable of great improvement or entire cure by plastic operations, perhaps combined with excision of portions of the organ.

Phimosis.

Elongation of the prepuce with contraction of its orifice. It may be congenital or acquired. In either case, but especially the former, the mucous layer of the prepuce is apt to be more or less adherent to the glans penis, while smegma collects and decomposes around the corona, producing great irritation. Not uncommonly these sebaceous concretions calcify. Acquired phimosis generally results from irritation, produced by long-continued uncleanliness, cicatricial contraction of the preputial orifice or gonorrhœa. A very acute form of phimosis often has origin in the swelling, retained secretions, and inflammation incident to acute gonorrhœa or chancroids beneath the prepuce.

Fig. 451.

Phimosis. (Smith.)

The condition predisposes markedly to the acquisition of venereal disorders; may give rise to obstruction to micturition, cystitis, or to reflex spastic palsy, general or local spasms. As result of straining to pass water, prolapse of the rectum or hernia may occur. In adult life phimosis may interfere with copulation or reproduction.

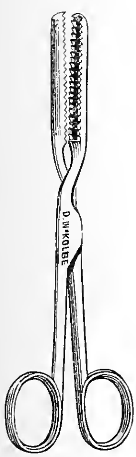
Treatment.—In every case where difficulty is experienced in retracting the prepuce, or where adhesions or irritative collections of smegma are present, operation for its permanent relief should be urged. For this purpose either of two methods may be resorted to: 1. Slitting up the prepuce; or, 2. Circumcision.

1. Insert a small grooved director into the preputial orifice and carry its point gently over the anterior surface of the glans exactly in the median

line to the corona. Now with knife or scissors slit up the prepuce upon the director, as a guide, to an equal distance. More frequently than not the mucous layer of the prepuce will be pushed ahead of the director and only the cuticular layer will be cut. If so, then reinsert the instrument beneath the undivided portion and divide it likewise. When adherent to the glans this flap is torn free to the corona on all sides with the fingers. Now its corners are trimmed round and the two layers are sutured together at a few points with catgut. A little iodoform is rubbed into the wound and an antiseptic dressing with a button-hole cut in it is slipped over the glans. A large wad of cotton is placed over the whole, retained by a diaper or T-bandage, and changed as often as necessary. If the penis is large the dressing may be applied around it and retained by a narrow bandage.

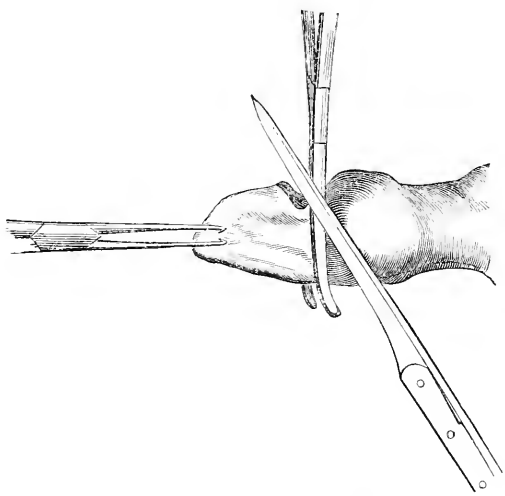
2. *Circumcision.*—Without pulling the foreskin down, grasp it at the middle of the glans in an antero-posterior obliquely downward and forward direction with a pair of catch forceps. Fasten them, and with a short knife or scissors cut through the grasped prepuce immediately in front of the forceps. This will usually remove a circle of integument, but leave the mucous layer embracing the glans tightly. This latter is divided upon a director, as above described, and the two flaps thereby formed are sutured at several points to the skin wound. Any bleeding

FIG. 452.



Phimosis forceps.

FIG. 453.



Circumcision. (ERICHSEN.)

should be controlled by suture or ligature, especially when from the artery of the frenum. Dress as above described. Subsequent hemorrhage—which should be examined for at frequent intervals during the first twenty-four hours—must be controlled by opening the wound and ligating the bleeding point.

Paraphimosis.

Paraphimosis denotes that condition which exists when a tight foreskin becomes retracted behind the corona and there caught. Mild de-

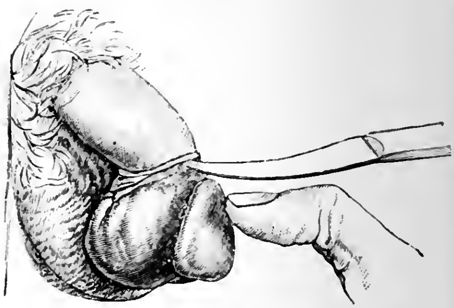
grees, and all when early dealt with, seldom result in serious consequence, but when the condition has lasted some time great swelling, inflammation, or even gangrene, with severe constitutional involvement, may take place.

TREATMENT.—Paraphimosis can, as a rule, easily be reduced by grasping and making traction upon the penis with one hand, while the fingers of the other make steady pressure upon the glans. Or, the glans may be tightly wound about (as a top) with a cord, which, when all œdema has been reduced, is quickly taken away and the swollen foreskin pulled over the glans. Again, when these measures fail, or great swelling or inflammation is present, the band of constriction should be divided in the median line in front. This incision will always allow the prepuce to be brought down. No sutures are required. Recurring paraphimosis should be treated by circumcision.

FIG. 454.

Reduction of paraphimosis. (PHILLIPS.)

FIG. 455.



Dividing the constricting band in paraphimosis. (BRYANT.)

Inflammation of the Penis.

Inflammation of the penis may arise from injury or extension from a virulent ulcer or contiguous parts. Either the body of the organ or its integument may be affected. Either variety may progress to purulent formation, gangrene, or extend to the scrotum, pubis, and abdominal wall. Permanent induration, or calcification of portions of or the entire penis, may result from chronic inflammation. Cases of inflammation of the organ with great swelling, more particularly in children and where no palpable cause exists, should be carefully examined for strings or bands placed around the organ for mischief, and which subsequently have become buried in the swollen tissues.

Balanitis

Inflammation of the mucous or inner surface of the prepuce. Retained normal or pathological secretions (as gonorrhœal pus) are the usual cause. The affection almost always coexists with *posthitis* (then termed balanoposthitis), an inflammation of the epithelial covering of the glans penis arising from like causes.

Treatment.—The *treatment* consists of cleanliness and, so far as possible, removal of the cause. Astringent drying powders are of value. Circumcision may occasionally be demanded.

Herpes.

Herpes upon the glans and around the preputial margin are of frequent occurrence and of great annoyance because of the intense itching. They resemble herpetic eruptions elsewhere and are caused usually by decomposing or irritative secretions.

Treatment.—Scrupulous cleanliness, drying powders, zinc ointment, or, for very persistent cases, circumcision.

Chancre and Chancroid of the Penis.

Chancre and chancroid are much more commonly found situated upon the glans penis and prepuce than anywhere else upon the body. The diagnosis and treatment of chancre have been already described (see Syphilis).

Chancroid (soft or non infecting chancre) occurs most frequently at the junction of the glans and prepuce upon the corona glandis. There may be one, two, or more present. These sores present the following characteristics: They begin within a few days or even hours after the deposit of the poison as a pustule or irritated abrasion; several may develop successively and others are almost certain to develop at points of contact with healthy skin or mucous membrane. Pus from one sore invariably produces a similar sore when inoculated elsewhere. When fully developed chancroids appear as one-fourth to one-half inch in diameter, vari-shaped, but usually ovoid, rather shallow ulcers with clean-cut—punched out as it were—edges, having a depressed floor of grayish slough from which exudes profuse sanious discharge. They are surrounded by an undefined zone of bright red inflammatory infiltration, and upon irritation may greatly increase in size and depth and cause extensive necrosis. The inguinal glands always early become inflamed (bubo) and commonly suppurate. The nearer the sore is to the frenum, the more marked is the glandular involvement of the corresponding side. Some chancroids heal kindly without great gland inflammation in the course of a week or two, while others take on more decided inflammatory action, increase much in size and cause abscesses in one or both groins, while yet others, especially in persons debilitated by bad food, exposure, or debauchery, become exceedingly severe and spread most extensively and destructively (phagedenic ulceration or gangrene sometimes simply termed "phagedena.").

The diagnosis between chancre and chancroid (see p. 79) cannot be positively made except by the appearance or non-appearance, as the case may be, of secondary syphilitic manifestations.

Treatment.—Most chancroids heal promptly when great cleanliness is combined with liberal applications of iodoform powder. Indolent sores should be stimulated by such applications as strong solutions of nitrate of silver; spreading sores by nitric acid; and phagedena by nitric acid, bromine, or actual cautery to the entire affected area, supplemented by vigorous constitutional stimulation and support. Inflammation of the inguinal glands may sometimes be aborted by leeches or blisters, but when suppuration occurs prompt incision, curetting and packing should be resorted to. Long-continued discharge from sinuses thereby resulting,

or repeated formation of abscesses, should be met by excision of all the affected glands.

A tight prepuce interfering with treatment, or causing retention of secretions, should at once be slit up, and allowed to heal by granulation.

Tumors of the Penis.

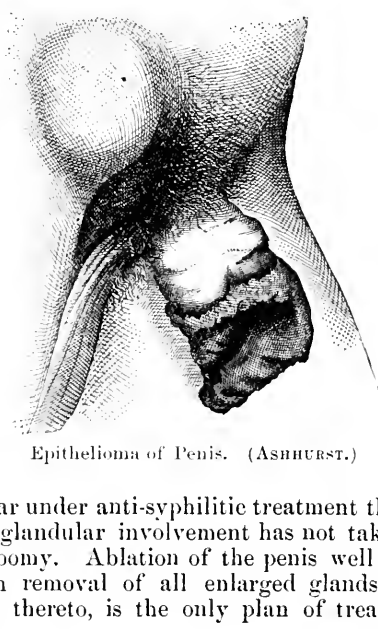
Papilloma.

Papillomata (warts) are very common about the glans and prepuce, and are almost always of syphilitic origin. The corona and preputial margin are the most usual points of development. The parts should be kept clean and dry by application of powders of calomel and zinc oxide (1 to 2) or tannic acid. This failing, they may be painted with nitric or chromic acid, or, best of all, snipped off with scissors, and the base or pedicle touched with nitric acid, or, should free bleeding occur, with the cautery.

Carcinoma.

Carcinoma, usually of the epitheliomatous type, may attack the penis. It may at first involve the glans or prepuce alone, but sooner or later all portions of the penis are involved, and later, the inguinal glands and tissues of the scrotum and pubis become likewise diseased. It can be mistaken in the early stages for manifestations of syphilis, but should the

Fig. 456.



Epithelioma of Penis. (Ashhurst.)

process not disappear under anti-syphilitic treatment the former diagnosis is maintained. If glandular involvement has not taken place, prognosis is fair, otherwise gloomy. Ablation of the penis well behind the affected area, together with removal of all enlarged glands in the groin and lymphatics leading thereto, is the only plan of treatment offering any chance of success.

Injuries of the Penis.

Contusions and integumentary wounds call for no special description. *Rupture* of the sheaths of one or both corpora cavernosa ("fracture of the penis"), occasionally takes place as result of violence to the organ while it is in the erect state, and constitutes a very grave accident. At once there is a subsidence of the erection, great shock and pain, nausea, and extravasation of blood into the penile tissues, and the whole organ becomes greatly hypertrophied thereby. The blood may find its way into the scrotum or upon the abdomen.

Suppuration and gangrene are apt to occur—more particularly when urine is also at the time, or subsequently, extravasated into the tissues—unless free incisions are at once made in all directions of extravasation. When recovery takes place, traumatic stricture and an indurated deformed organ, unfit for copulation, usually results.

Excision of the Penis.

The parts having been cleansed and shaved in the usual manner, and an umbrella ring or other tourniquet applied to the root of the organ, the skin is drawn well forward, and a circular integumentary incision made well above the diseased area.

The corpora cavernosa are then divided at the same level, and the spongy body at a point half an inch nearer the glans. The latter portion is now split for a distance of half an inch longitudinally, and each half of the urethra sutured laterally to the skin of the corresponding side. All hemorrhage is stopped, a catheter introduced, and an antiseptic dressing applied. The catheter should be taken out on the second day, and natural micturition may be permitted from that time on. If the stump is very short the patient must be provided subsequently with a short canula or catheter, through which to direct the stream of urine.

The Vulva.

Adhesion.

Adhesion of the vulvar lips may be recognized upon separating the labial folds, when no introitus vagina is visible, and a thin bluish membrane connects the labia.

Treatment.—After puncture with a knife the membrane may readily be broken down with a finger introduced through the incision. Any bleeding vessels should be ligated and the parts kept well separated by a plug for twenty-four hours.

Varix.

Varix of the pudendal veins usually exists in conjunction with varicosity of the leg veins, but may occur independently. The veins sometimes attain great size, but as a rule cause little distress or danger, unless they become ruptured either spontaneously or by traumata, as in childbirth. Subcutaneous rupture gives rise to hematocele, external rupture to violent bleeding.

Treatment.—When laceration takes place, cold compression should be applied to mild cases, ligation to more serious ones.

Hematoma.

Infiltration of the pudendal tissues with blood. This condition may result from rupture of varicose veins or from subcutaneous injury, and usually the tumor attains the size of an orange. The mass may be absorbed, become a blood cyst, or suppurate. Inflammation originating therein may travel beyond the vulvar limits, even into the deep pelvis.

Treatment.—Cold and moderate pressure at first; later, if it persist, incision and drainage—the latter always upon first signs of inflammation or abscess.

Vulvitis.

Inflammation of the vulva is particularly apt to arise in the labia, from such causes as contusions, wounds, uncleanliness, foul vaginal discharges, or the presence of parasites (as oxyuris vermiformis), and as a complication in low fevers or general depraved conditions. It may be acute, chronic, or limited to the vulvar follicles. In certain acute cases abscess, sloughing, or spreading gangrene (noma vulvæ) may develop. The last mentioned variety much resembles cancrum oris, is likewise almost confined to strumous children, and in this situation becomes equally, if not more dangerous.

Treatment.—Cleanliness, vaginal douching, and hot moist applications will alone be required for most cases. Abscesses should be opened at an early stage, curetted, and packed. Spreading gangrene should be met with liberal stimulation, quinine, and locally with free incisions and applications of bromine or actual cautery.

Follicular Vulvitis.

Inflammation of the subaceous and hair glands of the labia and genitocrural folds. It is quite common during pregnancy and in the unclean. The parts are œdematous, hot, and subject to an intense burning itch. The connective tissues are infiltrated and the follicles stand out hard, red, and vesicular or pustular.

Treatment.—Cleanliness and applications of carbolic or lead-water and laudanum lotions. Certain cases will defy all treatment until pregnancy ends.

Inflammation of the Vulvo-vaginal Glands.

This is a very common affection of this region. The glands lie one on each side of the vaginal outlet in the base of the lesser labia between two layers of the ischio-pubic fascia, and communicate with the surface at the vulvo-vaginal junction by ducts one-half inch in length. They are particularly liable to irritation by septic discharges travelling up these ducts. One or both may be involved, and abscess is the usual result. Diagnosis is made by palpating the bodies, or their location, between one finger in the vagina and another upon the labium minor: a hard, round, or fluctuating tumor is felt between them.

Treatment.—Hot applications until pus forms; then early incision through the labium.

Destructive Ulcers.

The vulva is liable to several forms of destructive and perhaps hypertrophic ulceration. These embrace lupus, tuberculosis, syphilis and epithelioma, all of which are most prone to develop in cachectic, unclean and loose women. Differential diagnosis is often impossible until late stages.

TREATMENT.—The treatment should include, according to the nature of the process, general supportive and antisyphilitic measures, excisions and cauterizations. Excepting in those yielding promptly to anti-syphilitic treatment the prognosis is unfavorable.

Chancre and Chancroid.

Chancre and chancroid frequently develop upon the vulva—especially in its deeper folds and at the vulvo-vaginal margin. Chancroids in this region are prone to become phagedenic in type.

Elephantiasis.

Elephantiasis of the labia and clitoris occurs with more frequency than do analogous troubles in the male organs. Syphilis would appear in this case to be the usual cause. Diagnosis and treatment do not differ essentially from those in the male.

Tumors.

The vulva is frequently the seat of syphilitic condylomata and warts, papillomata, lipoma, fibroma and epithelioma, all of which, except epitheliomata, have a marked tendency to become pediculated and ulcerated. Sarcoma is almost unknown. Cysts of the vulva almost invariably have their origin in the vulvo-vaginal glands or from hematomata.

INJURIES.

Injuries of the vulva, excepting lacerations of the perineum, call for no special description.

Laceration of the Perineum.

This occurs as an accident during labor, and may be of any degree, from mere tearing of the fourchette to rupture down to or even through the anal sphincter and for some distance up the rectum through the recto-vaginal septum. Tears down to the sphincter give rise to a sense of weakness and to more or less prolapse of the pelvic organs from lack of their natural support, while lesions involving the sphincter accentuate the above symptoms and permit incontinence of flatus and feces.

TREATMENT.—Every woman should be examined for possible laceration immediately subsequent to delivery. If such is found to exist deep sutures should at once be passed from side to side in a transverse direction to the tear. Where healing of the laceration has already taken place the bowels should be well cleared out by a purge and enemata. The patient is then placed in the dorsal position upon a table with the hips at the edge. The operator sits between the legs, facing the parts. Denudation with scissors

or knife of all cicatrized areas and especially of those running backward and upward on either side of the vagina is now made. If the tear runs into the rectum the edges are also here denuded thoroughly, and the retracted ends of the sphincter exposed. Sutures of silkworm-gut are then passed from apex to base of the vaginal denudations, there brought out, reinserted and brought back to the lower edge of denudation in such manner that when they are tied the edges of each lateral denudation are

Fig. 457.

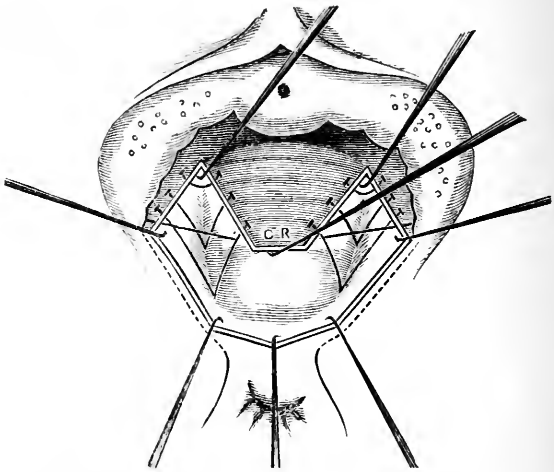


Diagram of denudation and suturing in operating for perineal laceration. (Kelly.)

brought together on each side of the vagina near its outlet. These sutures should be placed four to an inch, embrace no skin, and be tightened, shotted, and cut off short. Then are inserted two or three stitches which enter skin on either side and pass through all the tissues above the sphincter, and emerge through skin on the opposite side; but if the sphincter is torn, two or more sutures should include integument and its denuded ends. The latter are now also tightened and shotted. A teaspoonful of iodoform is then placed in the vagina and rubbed into the wound. No dressing is required. The urine must be drawn by catheter until the patient can voluntarily pass it. The bowels should be kept fluid after the first day by saline laxatives. Sutures may be removed on or after the tenth day. If irritation or discharges develop, vaginal douching should be employed.

The Vagina.

Congenital Abnormalities.

Congenital abnormalities of the vagina are chiefly important in the interference which they may offer to the escape of menstrual discharges, to childbirth, and to sexual congress. They comprise: absence of or rudimentary or double vagina, atresia, stricture, and imperforate or unusually

well-developed hymen. The canal may also terminate anomalously in the bladder or rectum. Stricture may also be *acquired* as result of cicatrization of ulcers or wounds, or by organization and contraction of inflammatory deposits.

Treatment.—Imperforate or persistent hymen can readily be relieved by making a small incision into the membrane and tearing it up to the vaginal wall. Hemorrhage must then be controlled and a large plug of dressing kept in for a day or two. Stricture—whether congenital or acquired—may be treated by dilatation, perhaps combined with incisions, but these measures must be guided by the greatest prudence and caution to prevent injury to the peritoneum, rectum, and bladder.

Retained Menses.

Retained menses may be diagnosed when at the usual period of puberty they do not appear, while each month there recur attacks of pelvic pain accompanied by severe constitutional disturbance, and, upon inspection, a tense, bulging, fluctuating tumor presents at the vaginal orifice, and may extend even largely into the pelvis and abdomen. When this condition is not promptly relieved a fatal result may ensue from peritonitis incident to rupture of the accumulation into the abdominal cavity, or from suppuration in the vaginal walls or neighborhood.

Vaginitis.

Vaginitis, either simple or specific (gonorrhœal), is very common. The latter variety corresponds to infectious *urethritis* in the male.

Treatment.—The treatment of both forms consists of cleanliness and frequent removal of discharges by copious injections of hot antiseptic fluids and, later, of astringent solutions. Vaginitis is generally quite amenable to treatment and is rarely followed or accompanied by complications other than subsequent disease of the uterus (metritis) and its appendages (salpingitis).

Chancre and Chancroid.

Chancre and chancroid find their most common site in the female in the vagina near its orifice, and are here liable to produce the same complications as when elsewhere situated.

Fistulæ.

Fistulæ between the vagina and bladder (vesico-vaginal), urethra (urethro-vaginal), or rectum (recto-vaginal) are frequently met with. They usually result from sloughing following difficult childbirth or from venereal and other ulcerations, although wounds, either surgical or accidental, may give them origin.

Owing to the consequent incontinence of urine or flatus and feces and the excessive irritation incident thereto, the patient's plight is indeed a miserable one.

Treatment.—Very small fistulæ may sometimes be induced to close by repeated stimulation of their edges with a hot wire or caustic, but persistent or larger openings must be dealt with by a plastic operation.

Operation.—The patient's bowels having been cleared out she is placed in the lithotomy position for bladder, or the knee-chest attitude for rectal openings, and the vagina, if necessary, is well exposed by a Sims's speculum. The mucous membrane is then carefully dissected for one-third of an inch in all directions about the fistulous opening in the vagina with knife or scissors. Now transverse sutures of silk, silk-worm-gut, or wire are inserted, six to the inch, in the following manner: The needle is entered one-fifth of an inch beyond the denuded area, carried through the muscular wall of the vagina to the fistula margin; it is then brought out and reinserted into the muscular coat upon the opposite side of the fistula, carried through it and brought out likewise one-fifth of an inch beyond the denudation. The sutures thus inserted are then tightened and fastened by tying, shotting, or twisting, according to the suture material employed. If a vesico-vaginal fistula, a catheter should, subsequent to the operation, be passed at frequent intervals or left in with a tube attached running over the side of the bed into a suitable receptacle. In any case the bowels should be moved by a saline purge daily after the first twenty-four hours. If the fistula is very extensive it may be necessary to turn flaps from the vaginal wall into it and there suture them in similar manner.

Fig. 458.

Sims's speculum.

Tumors.

Tumors of the vagina are rare. They may be cystic, papillomatous, fibromatous, or carcinomatous.

Foreign Bodies.

Foreign bodies may, by accident, or lascivious, or other intent, find their way into the vagina. No definite rules can be laid down for their extraction.

Wounds.

Wounds of the vagina usually occur during childbirth or coitus, but may also be caused by accidental, surgical, or criminal means. They are extremely dangerous when the peritoneal cavity is entered.

Treatment.—The vulnerating body must be removed if still present, the vagina thoroughly cleansed, drained, and its orifice well protected by antiseptic dressings, which should be renewed each time that urination occurs. Peritoneal inflammatory involvement will demand immediate abdominal section, irrigation, and drainage.

CHAPTER XXV.

DEFORMITIES, OR ORTHOPÆDIC SURGERY.

Torticollis, or Wry-neck.

Pathology.—Wry-neck is the name given to rotary deviation of the head caused by contraction of the cervical muscles. The muscular spasm may be spastic or permanent; or it may be spasmodic, and then is usually accompanied by pain whenever the spasm producing the deformity occurs. Hysterical contraction of the cervical muscles may give rise to hysterical torticollis. A similar deviation of the head may be due to a paralytic condition of one of the groups of muscles, and also to cicatricial contraction of the skin and subcutaneous structures after severe burns or other destructive injury. The sterno-mastoid muscle is most frequently the seat of the abnormal contraction, though in many cases the trapezius muscle and the scalene muscles may be involved in the affection. In some instances the splenius capitis and deep rotators of the head seem to be the displacing agents. The affection usually involves one side of the neck, but cases are described in which the cervical muscles of both sides have been abnormally contracted. Congenital torticollis is a malformation or is due to injury received at birth, but it is usually the acquired form which comes under the surgeon's notice.

Torticollis results from the head being held for a long time in a strained position, as in inflammation of the cervical glands; to myositis or inflammation of the muscles due to rheumatism, gout, or other causes; to spasm of the muscle induced, probably, by lesions of the central nervous system; to muscular spasm the result of injury, and reflex irritation, such as intestinal worms. A mild form of torticollis occurs after exposure to cold, and is called by the laity "stiff-neck."

The distortion caused by caries of the cervical vertebræ is not strictly torticollis.

The pathological changes which occur in long-standing cases are alterations of the shape of the bones and ligaments, and degeneration of the contracted muscles.

Symptoms.—Wry-neck, due to exposure to cold, occurs as a slight rigidity of the cervical muscles, and is attended with pain on attempts at motion. Typical torticollis, due to contraction of the sterno-mastoid muscle of one side, causes the head to rotate, so that the face is turned to the opposite side, and the chin slightly elevated. The muscle which is the cause of the deformity is prominent and tense. The shoulder on the side corresponding to the affected muscle is often somewhat elevated, and a slight spinal curvature in the dorsal region is not uncommon. The exact character of the displacement varies with the muscle or group of muscles involved.

In the spastic contraction there is little pain, but in the spasmodic form the head, which is ordinarily in the normal position, is persistently and violently jerked to one side, while severe pain is felt in the con-

tracted muscle or muscles on the opposite side of the neck. In some cases this painful spasm and rotary displacement of the head occurs when the least attempt is made to walk or to use the arms. In other cases the spasmodic contraction occurs at frequent intervals without reference to voluntary movements.

TREATMENT.—Mild rheumatic torticollis is cured in a few days by the application of heat, by means of bags filled with hot water, sand, or salt, and rubbing with stimulating liniments, aided perhaps by hypodermic injections of atropia (gr. $\frac{1}{100}$ to gr. $\frac{1}{60}$).

The spastic form may be relieved by general anæsthesia, and, if of hysterical origin, will probably not return. In other cases a collar-like apparatus may be so adjusted as to prevent a reproduction of the deformity when the patient comes out of the anæsthetic state. Other cases require myotomy or division of the displacing muscle. If this be the sterno-mastoid the tenotome should be introduced beneath the muscle at its internal edge, just above the clavicle, and as much of the muscle divided as seems necessary. It may require two punctures with the tenotome to enable the surgeon to divide both the sternal and clavicular heads of the muscle without running great risk of injuring the deep vessels.

After the muscle has been divided, the head should be turned to its normal position; but it is said to be well to return it to the abnormal position and leave it there for two or three days before beginning active manipulation or mechanical treatment to bring the head into the natural position.

It is often difficult, in the more complicated cases, to decide what muscles are responsible for the deformity. A careful study of the character of the rotary displacement is therefore demanded. It is especially important to recollect that in sterno-mastoid contraction the head is turned to the side opposite to that of the affected muscle. Electricity and gymnastics will do a great deal here, as in other muscle deformities. Apparatus, whether consisting of steel springs or rubber bands, may be available as accessory agents, but they can seldom take the place of active and passive muscular movements. The spasmodic form is exceedingly intractable. Myotomy and excision and stretching of the spinal accessory nerve have been attempted with but moderate success. This nerve is reached by an incision along the posterior border of the sterno-mastoid muscle, after which the edge of the muscle is turned up and the nerve found entering its lower surface. Excision of the upper cervical nerves at the base of the occiput has been performed in at least one case where the deep rotators were supposed to be at fault. The fluid extract of gelsemium in very large doses has given fair results in some cases. Preparations of this drug vary greatly in strength, and minimum doses should be used at the beginning of the treatment. I have, however, used as much as thirteen minims every two hours during the day and night for several weeks and found satisfactory results from it. Massage as well as passive motion should be used as adjuncts.

SPINAL CURVATURES.

PATHOLOGY.—At birth there are no curves in the infant's spine, but as the child assumes the sitting or erect posture, curves which are recognized as the normal vertebral curves, are developed. Weak muscles, careless postures, the prolonged retention of positions causing abnormal

curves of the spine and paralysis of special groups of spinal muscles are causes of spinal curvature. Rickets and other agencies tending to interfere with normal development of the growing skeleton are sometimes causes of these distortions in the young.

Angular antero-posterior curvature of the vertebral column which is due to caries or tuberculosis of the vertebral bodies, belongs to and is discussed in the section on Joint Diseases. Its pathology is naturally distinct from the spinal deviations now under consideration.

The rotary lateral deviation of the spine, to which the name scoliosis is applied, is the most common form of spinal curvature. Kyphosis, the form in which the convexity of the column is increased in a posterior direction, is less common; whereas lordosis, or increased convexity forward, is comparatively frequent.

These deviations of the spinal column are due to relaxation and debility of the spinal ligaments and muscles, or to some vicious position assumed while at work or at rest which has a tendency to maintain the spine in an abnormal position for a considerable portion of the day. As a consequence the bones, the inter-vertebral cartilages, and the ligaments become more or less misshapen, and the deviation becomes confirmed. Congenital curves of the spine are at times seen.

Rotary Lateral Curvature, or Scoliosis.

Rotary lateral curvature, or scoliosis, is particularly common in young girls about puberty. There is some rotary twisting of the vertebral bodies as well as a lateral curving. Ordinarily, there is a dorsal curve, with its convexity to the right and a compensatory curve in the lumbar region with the convexity to the left. There may be four curves in the length of the spinal column, but this is uncommon. Sitting at school-desks with one shoulder unnaturally elevated; carrying an infant constantly on one side, and occupying a lolling position during the greater part of the day, will tend to lateral curvature in growing girls about the menstrual epoch. Inequality in the length of the legs, due to disease of the joints, or to asymmetry in length, will equally lead to lateral curvature. Deformity of the chest from pleuritis, wearing an artificial leg, and ankylosis from hip disease may be similar factors in spinal distortion. Rickets is a predisposing cause, as well as of osseous deformities in other parts of the skeleton.

Projection of the posterior border of one scapula and pain in the corresponding shoulder and the back may be the first symptoms to attract attention. The pain may be scarcely noticeable during the day, but is felt at night, or when lying down or sitting. The winged scapula, as this deformity is termed, becomes more marked, next a deviation of the dorsal spine in the lateral direction is observed, and soon a secondary compensatory curve appears in the lumbar region. Rubbing the skin over the spinous processes of the vertebræ will cause red spots to appear over these bony prominences, so that the surgeon can readily determine the absence or extent of the spinal curvature. The spinous processes, however, are in reality less displaced than the bodies of the vertebræ themselves, which have undergone lateral and rotary displacement. The viscera may be injured and compressed by the deformed skeleton, and some anatomical change in the position of the vertebral ligaments may arise secondarily. If the deformity is great a deep sulcus occurs between the lower ribs and

the ilium on the side of the body corresponding with the convexity of the dorsal curve. The ribs and ilium may actually override, and bursæ may be formed from friction.

Fig. 459.

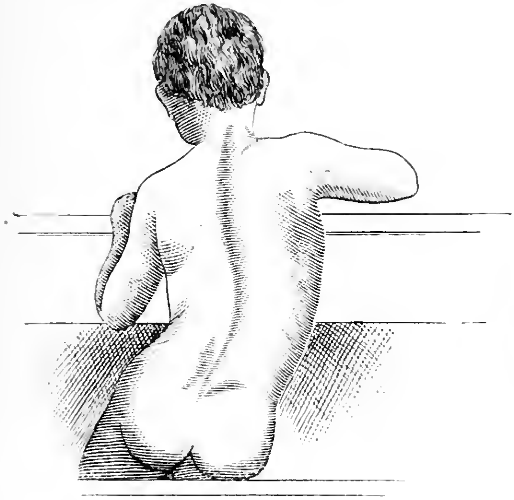


Fig. 460.

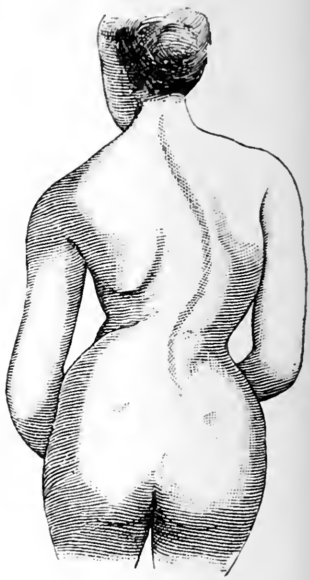


Fig. 459.—Vicious position during writing. (Reeves.)

Fig. 460.—Right lower dorsal and left lumbar curvatures, showing unequal height of shoulders and folding of the soft parts in the left ilio-costal region. The left hip is higher than the right. (Reeves.)

Kyphosis.

Kyphosis, or round-back, is a bending of a part or whole of the spine so that the convexity of the curve is backward, giving the patient the appearance called round-shouldered. The term is not used in connection with angular curvature due to tuberculosis of the vertebræ. Kyphosis occurs in children and in old persons, and is commonly in the upper portion of the dorsal region. In long-standing cases ossification of the vertebral joints, so that the bodies become ankylosed, may take place. Rickets and faulty positions while at work, or at rest, may be the cause of the deformity. It is an indication, also, of the increasing debility of the tissues which occurs in the aged. Dyspnœa and other visceral symptoms may be induced in aggravated cases.

Lordosis.

Lordosis, or hollow-back, is a spinal deviation in which the convexity of the curve is forward; it is usually found in the lumbar region, due to an aggravation of the normal lumbar curve. Congenital dislocation of the hips gives rise to lordosis. Carrying heavy weights on the head is another cause. Pregnancy and abdominal tumors give rise to temporary

lordosis, because the patient must bring the centre of gravity further back in order to neutralize the weight in front of the median plane.

Hollow-back, whether occurring in the lumbar region or the cervical region, is characteristic. When the patient lies upon a hard mattress the arching of the spine is conspicuous. There may be compensatory kyphosis, and in kyphosis there is often compensatory lordosis. Uterine and other visceral trouble may occur secondarily.

Treatment.—The prevention of spinal deviation is exceedingly important in young subjects presumably liable to such a deformity. Gymnastic exercises and abstinence from positions, whether at school or at work, that tend to exaggerate the normal curves, should be enforced. Even slight deviations should be subjected to treatment, because they may be entirely cured. Absolute restoration of the outline is impossible when the bones have been permanently deformed by pressure, or when ankylosis between the vertebral bodies has occurred. The general health should be improved by tonics and out-door exercise, and by abandonment of the injurious habits which tend to confirm the deformily. Gymnastic exercises to develop weak muscles or to draw the bones into proper position, should be instituted, but they should not be permitted to be carried far enough to fatigue the patient. Swinging by the hands from a trapeze, or from the top of a door-way, will straighten out the curves by the traction exerted by the lower limbs. The use of dumb bells and Indian clubs, and massage, are valuable in developing the muscles. Propping up certain portions of the trunk while lying down, or the use of a spring, such as is shown in the diagram, to make pressure upon the distorted spine, will be found at times efficacious in relieving the deformity.

The motions used in swimming are good exercise for a patient with lateral curvature, and they may be performed in the air by having the patient lie upon a proper support. All these mechanical measures must be continued for many months before benefit can be observed.

Mechanical support is valuable as an adjuvant in developing the muscular system, and may, therefore, be useful in the intervals when rest from the more active treatment is required. In rotary lateral curvature a pelvic band with crutch heads extending up into the arm-pits may be worn. A jacket or cuirass of gypsum bandages fitted to the patient when he is suspended, to straighten out the curves, has advocates. If these means prevent increase of the deformity and augment normal muscular development, the tendency to spinal deviation will disappear as the patient grows older.

Fig. 461.

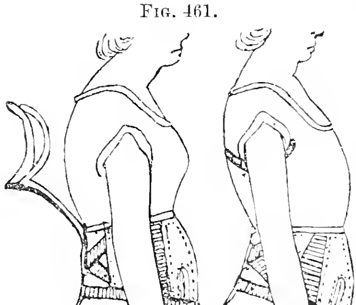


Diagram of dorsal kyphosis before and after application of a spring corrector. (Reeves.)

If the lateral deformity depends upon one leg being shorter than the other, the lower extremities should be made of equal length by increasing the thickness of the sole of the shoe on the short limb. It is possible that making the legs of unequal length by wearing a high sole may be utilized as a treatment for correcting spinal curvature from other causes than asymmetry of limbs.

Kyphosis requires a similar kind of treatment, though the muscular

exercise should be adapted to the character of the deformity. The spring corrector applied in many cases is represented in the figure.

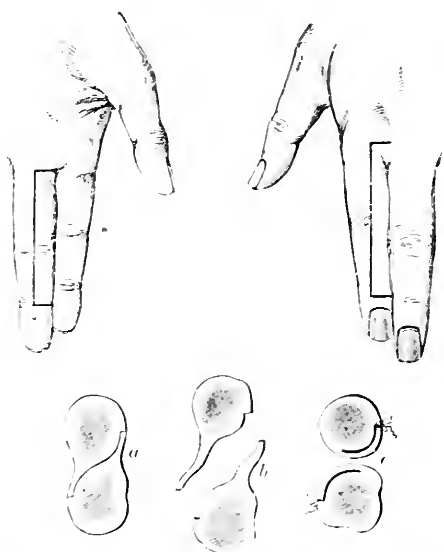
If ankylosis of the vertebræ has occurred, cure is not to be expected. Rupture of such osseous or fibrous bands has in some cases been attempted, and has been successful. There is an element of danger in this forcible method of treatment, which, of course, should never be applied in ankylosis after tuberculosis of the spine or Pott's disease, which is sometimes included under the term kyphosis.

Lordosis is managed in a similar manner, but the pressure from the apparatus is so applied as to push forward and compress the dorsal curve. The patient's shoulders and hips may be so elevated when lying in bed as to diminish the lumbar curve, and thus tend to correct the deformity. It must be evident that for the successful management of spinal curvature, some ingenuity on the part of the surgeon will be required. Although the aid of steel springs and rubber bands, and other mechanical appliances is often essential, it is upon the muscles that dependence is to be placed in preventing and overcoming the distortion. Much patience is demanded on the part of the patient.

Webbed Fingers.

The term webbed fingers is applied to the congenital deformity in which two or more fingers are fastened together by cellulo-cutaneous

Fig. 462.



Operation for webbed fingers. First two figures show lines of incision on back and front of fingers. Third figure shows: *a*. The lines of the two incisions uniting so as to divide the web and leave a flap on each side. *b*. The flaps detached from one finger while adherent to the other. *c*. The flaps applied to the fingers and covering the raw surfaces. (Reeves.)

bands extending across the inter-digital notch. The band may unite the fingers throughout their entire length, or may join only small portions of

them. The deformity is only relievable by operation. One of the best plastic operations is to dissect a rectangular flap from the back of one of the fingers extending as far as its middle line, and to raise a similar flap from the palmar surface of the other finger extending as far as its middle line. The base of each of these flaps is of course left attached to the finger from which it is not taken, and extends over the web between the webbed digits. The subcutaneous tissue uniting the fingers is then divided, and the flaps carried around the sides of the two fingers in such a way as to have the two cutaneous surfaces presenting toward each other on the proximal sides of the previously united digits. If some such method is not adopted the raw surface made by cutting the fingers apart would unite at the base during cicatrization, despite the utmost care and thorough dressing.

Club-foot.

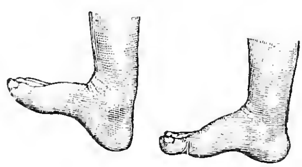
Pathology.—Talipes, or club-foot, is a deformed position of the foot, or part of the foot, in relation to the leg. It may be congenital or acquired. Usually the muscles, fascias and ligaments are contracted; sometimes the bones and cartilages themselves are misshapen. The deformity may depend upon congenital malformation of the structures of the foot, upon spasm of the contracted muscles, upon paralysis of the muscles which normally should oppose the contracted muscles, and upon other displacing agencies. Wasting of the muscles occurs secondarily, atrophy of the foot and leg results, and subcutaneous bursæ are developed at points upon which pressure comes during walking.

Congenital cases present a very great amount of distortion when the child is allowed to attain adult age without the adoption of proper means to cure the deformity.

Fig. 463.

Pes varus in the adult. (Treves.)

Fig. 464.



Pes calcaneus. The foot before and after section of the tendo-Achillis. (Treves.)

There are six varieties of talipes:

1. Pes varus; in which the inner side of the foot is raised, and the anterior part of the foot and the sole turned inward.

2. Pes valgus. This condition is the opposite of pes varus, and in it the outer side of the foot is raised and the sole turned outward.

3. Pes equinus. Here the heel is raised and the patient walks on the toes.

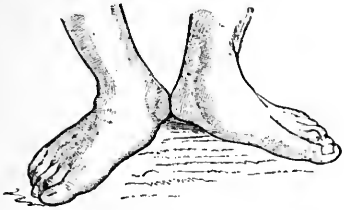
4. Pes calcaneus is the opposite of pes equinus. The toes are, therefore, raised and the patient walks upon his heel.

5. Pes planus; in which the arch of the foot is sunken and the entire sole rests upon the ground when walking.

6. Pes cavus is the opposite of pes planus. In it the arch of the foot is increased and there is a great hollow in the sole.

These six forms of talipes are the types, but the forms may be variously combined. For example: In equino-varus the heel is raised and the patient has the inner side of the foot elevated and the sole turned inward, while pes calcaneo-valgus is a form in which the patient walks upon the heel with the sole turned outward.

FIG. 465.



Pes valgus, or flat-foot. (TREVES.)

FIG. 466.

Pes cavus, or hollow-foot. (TREVES.)

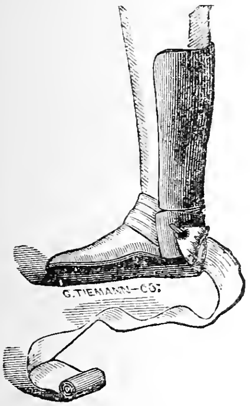
TREATMENT.—The treatment of club-foot requires many months and a combination of operative, mechanical, and physiological measures. Manipulations carried on for months by the patient's nurse, by which the muscles are developed and the foot forced in a normal condition, will frequently cure slight degrees of the deformity. In other cases, tenotomy of the tendons and fascias will be demanded, and will have to be supplemented with manipulations and apparatus in order to maintain the corrected position obtained by operation.

The most confirmed and marked cases are found in adults who have gone untreated. In these, and sometimes in very severe cases occurring in the young, excision of some of the tarsal bones is the only means by which a fairly good position of the distorted member can be obtained. It is rather rare that this severe operation is demanded in cases of congenital club-foot which come under skilful supervision during infancy. Cases of unsuccessfully treated club-foot, commonly called relapsed cases, are more difficult to handle than others presenting similar deformity, because after tenotomy has been done the patient's tendons and fascias become more or less matted together by adherent inflammation. Of late years, immediate correction of the deformity by great force, applied by the hands, or by means of screws operating upon pads applied to the foot, has become a favorite with some orthopædic surgeons. The corrected position so produced is maintained by the application of gypsum bandages to hold the foot in place.

The operation of tenotomy may be done upon infants after two months of life, if by this time efforts to overcome the deformity by manipulation have been unavailing, and in cases where it is evident that these simple measures will not be of service if they are kept up. After tenotomy the foot and leg should be bandaged to a well-padded splint of zinc, copper, or sheet iron, which will maintain the desired position. These flexible splints are cheap and can be altered from time to time as the surgeon desires. They facilitate greatly the change in position of the foot which is the object of treatment. After six weeks' use of the splint it may be dispensed with in congenital cases, but the little patient should be under the surgeon's eye at intervals until able to walk, and should even be watched by him after that date.

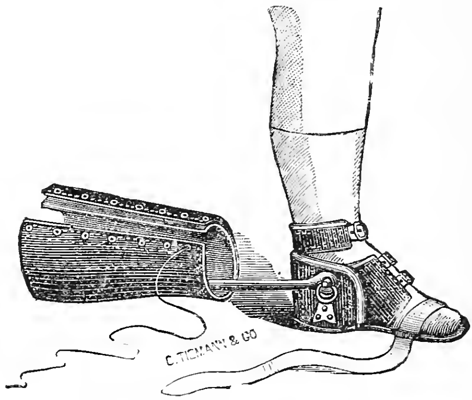
The greatest care is necessary to see that excoriations are not produced by the apparatus applied. Massage in its various forms should be continued during treatment. It is essential that the muscles of the leg be subjected to the influence of massage as well as those of the foot.

Fig. 467.



Reeves's universal talipes shoe.

Fig. 468.



Reeves-Scarpa shoe for severe cases.

Pes Varus.

This is the most frequent form of congenital club-foot. There is inversion of the anterior two-thirds of the foot, with turning-in of the sole and elevation of the inner part of the foot, so that the patient walks upon the outer part, or, in bad cases, actually upon the dorsum, of the tarsus.

In all cases of pes varus there is elevation of the heel, producing pes equino-varus. The inversion is due to the anterior tibial and posterior tibial muscles, and the long flexor muscles of the toes, while the elevation of the heel is produced by the calf muscles acting through the tendon of Achilles. The plantar fascia and other muscles than those mentioned may at times be contracted, and increase the deformity.

Fig. 469.

Diagram of a normal foot and one with pes equino-varus, to show internal deviation of the anterior part of foot. (Sayre.)

Treatment.—It is usually well in undertaking operative treatment for this condition to divide the operation into two stages if the deformity is a pes equino-varus and not a simple pes varus. The inversion of the foot should be first treated by tenotomy of the tibial tendon and of the posterior tibial tendon. Perhaps the plantar fascia and some of the other tendons may require section. The second stage, which is to relieve the elevation of the heel, should be undertaken several weeks later. If the case is one of pure pes varus, the first procedure alone is necessary.

After the deformity has been corrected by means of tenotomy, the foot, of course, is dressed with the flexible metal splints previously described, or possibly with gypsum bandages. The latter, however, is not so desirable in infants as in club-foot

of adults, because the skin is tender and more easily irritated. It is, therefore, better, if possible, to use metal splints, which can be removed daily, in order that the limb may be bathed and the condition of the foot observed.

In pes varus or equino-varus, whether due to congenital or acquired causes, more radical operations are sometimes demanded. Free tenotomy of all the restricting structures, without reference to their names, accompanied in many cases by the removal of a wedge-shaped portion of the tarsal bones, is at times the only method which will give a proper shaped foot. Cutting out a wedge-shaped portion of bone is called tarsectomy, and is performed by making a large elliptical flap to expose the bones, and removing with a saw, or by disarticulating with a knife, all the bony tissues that prevent the reposition of the foot. A drainage-tube is then introduced, the flaps and such tendons as are not factors in causing deformity are united by sutures, and the limb dressed with gypsum immovable dressings. The dressing may be left in position for several weeks, when, if the asepsis or antisepsis has been perfect, the wound will be found healed, except at the point where the drainage-tube makes its exit. The gypsum bandage may be removed, however, at an early period, in order to take out the drainage-tube. After such operations the foot is always shorter than the normal foot would be. This is due partly to the removal of a portion of the tarsus, and partly to the fact that the leg and foot are atrophied from imperfect development or from non-use of the muscles. Tarsotomy is the term used when the bones are simply cut through with a saw or chisel and no portion removed. This is sometimes effective. Occasionally, reposition of the inverted foot may be accomplished by forcibly bending it into position by means of the hands or strong screws attached to a suitably-shaped foot-clamp. Some slight inflammatory reaction is to be expected after this violent treatment. Apparatus or dressings of a retentive kind must be applied after the operation.

Pes Valgus.

Pes valgus is the condition opposite to pes varus, and is the turning-out of the sole, so that the patient walks upon the inner edge of the foot. It is very frequently associated with flattening of the arch of the foot, becoming then pes plano-varus. It is sometimes combined with pes calcaneus, and is then called pes calcaneo-valgus. Mild cases are managed by bandaging the foot into proper position by splints and pads placed on the inner side of the ankle. In more severe cases tenotomy of the three peroneal muscles, and of any other muscles tending to produce displacement, may be required. If the sole is flat, it may be necessary to insert in the shoe worn after the lateral deformity has been corrected, such a pad as will restore the arch of the foot. Resection of the astragalo-scaphoid joint may be required to restore the arch.

Pes Equinus.

This deformity is not often congenital. It is usually due to infantile paralysis of the muscles of a part of the leg, or to abscess or injury causing contraction of the calf muscles. It is to be treated by tenotomy of the tendon of Achilles.

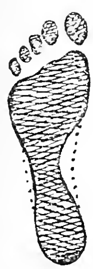
Pes Calcaneus.

Pes calcaneus is another form of club-foot which is not commonly congenital, and, like pes equinus, is quite often due to infantile paralysis of the muscles antagonistic to those producing the deformity. Pes calcaneus is treated by tenotomy of the displaced muscles, or by apparatus so arranged as to pull up the heel. Rubber bands are utilized in this as in other forms of club-foot. It has been suggested to cut out a portion of the tendon of Achilles and splice the two ends, in order to raise the heel and shorten the tendon of the calf muscles.

Pes Planus.

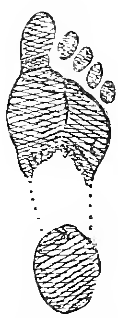
Pes planus, or flat-foot, is a flattened sole, due to obliteration of the normal arch of the instep. This form of club-foot is well demonstrated by covering the sole with shoe blacking and having the patient tread upon a piece of white paper. The imprint of the foot shows the entire foot coming in contact with the floor, and is a good diagnostic symptom of the existence of the deformity. In the normal foot it is simply the heel, *outer* edge, and the toes that touch the ground.

Fig. 470.



Impression of normal sole, with dotted lines showing borders of the foot. (Reeves.)

Fig. 471.



Impression of the sole in pes cavus. (Reeves.)

The pain produced by this giving way of the plantar arch is often mistaken for rheumatism or neuralgia. This breaking down occurs in persons of weak fibre, in those who are required to stand much upon their feet, and in those who are very heavy. An ingrowing toe-nail may cause it by reason of the manner of walking adopted to avoid pain from the diseased nail. As previously stated, the condition is often associated with pes valgus. Much comfort is often given by placing in the shoe a plate or pad to restore the arch of the foot. Muscular tone can be given the long flexor of the great toe by gymnastic exercises to develop the muscle. This may be done by having the patient raise himself upon his toes a number of times each morning, so as to bring these muscles into action. "Weak ankles" is a term often applied to a tendency to the occurrence of pes valgus, and is due to the relaxation of the internal lateral ligament of the ankle-joint. Massage and support of the ankle by a high-laced shoe, or some form of rubber or

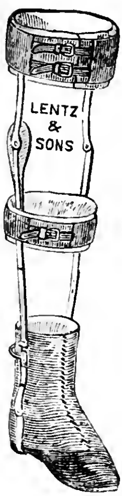
metal support, will, when combined with tonic treatment, usually be sufficient for the correction of this weakness.

Pes cavus, or hollow-foot, is treated by subcutaneous division with a tenotome of the plantar fascia, with or without division of the short flexor muscle of the toes. Improvement in gait and relief from discomfort are sometimes obtained by building up the interior of the shoe so that the sole will come in close contact with the excessive arch of the foot.

Deformities of the Knee and Leg.

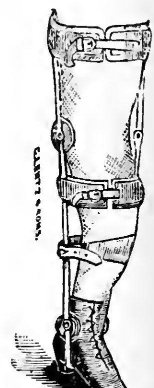
Pathology.—Knock-knee, or genu-valgum, is a deformity in which, when the patient is standing, the knees are close together or touch, while the internal malleoli are more or less widely separated. The opposite condition, in which, when the internal malleoli touch, the knees are more or less widely separated, is called genu-varum, or bow-legs. This latter condition is frequently associated with bowing outward of the tibias.

Fig. 472.



Apparatus for treating knock-knee.

Fig. 473.



Apparatus for treating bow-leg.

The deformity in knock-knee disappears when the knees are bent so as to bring the legs at right angles to the thighs. In this deformity there is not much pain, but usually a feeling of weakness after prolonged standing or walking, which may be associated with considerable discomfort. The deformity exhibited in the lower extremities, and the abnormality in gait of the patient, are sufficiently diagnostic. The condition may be due to rickets, but it may also occur from attempts at walking at too early a period while the bones and ligaments are scarcely developed in strength. Local paralysis, or a continuation of bad postures in early life, may also be factors in the causation of genu-valgum. The knee-joint shows a tendency to bend backward so that the popliteal space scarcely exists. The inner condyle appears relatively larger when com-

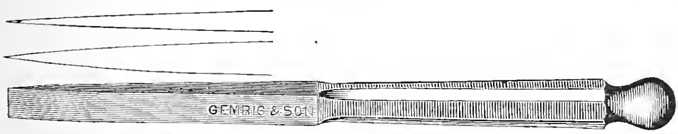
pared with the external condyle, but it is possible that this change of relation is due to improper development of the shaft of the bone.

Treatment.—In the early stages such joint deformities are often remediable by the use of apparatus which will, in case of knock-knee, draw the knee outward, and in the case of bow-legs press the tibia or knee inward.

In more advanced cases it becomes necessary to use more active measures. This consists in forcibly straightening the deformed limbs by manual power or by performing osteotomy, followed by the application of gypsum bandages to retain the fractured or cut tissues in their new position.

Osteotomy is usually performed by means of a chisel or osteotome. The latter is an instrument much like a chisel, except that it is bevelled on both sides instead of upon one. A saw is seldom used at the present time for performing osteotomy.

Fig. 474.



Osteotome.

In case of knock-knee the femur may be divided by a horizontal cut just above the external condyle, or at the junction of the middle and lower thirds. The relatively large internal condyle may be separated from the rest of the femur by an oblique cut made with the osteotome, so that the condyle will slip upward when the leg is brought inward to a normal position. Some operators prefer condyloid section; others, section above the condyles, or in the shaft. In performing osteotomy it is proper that the incision through the skin should be made in the long axis of the bone, in order to divide as few muscular fibres and tendons as possible. The osteotome is introduced with its edge in the direction of the incision, but subsequently it is turned to a right angle before it is struck with the mallet. The bone should be divided for about two-thirds of its thickness. The remaining portion of the bone is fractured, as the limb is bent into position. In the condyloid section the instrument should not go entirely through the condyle so as to enter the joint. Section through two-thirds of the bone at this point will permit ready fracture of the remaining osseous tissue; and the line of fracture is not so liable to cause inflammation of the joint as would one made by the instrument, although an aseptic wound of this sort is not apt to cause any complication. Some surgeons prefer to make the section through the shaft of the femur from the internal aspect of the thigh rather than through the external surface. By some operators it is thought advantageous to use one or two osteotomes, each of lessened thickness, for the deeper parts of the bone section. The thick osteotome makes the wound at the surface of the bone wide; the thinner instruments cause a narrower cut as the deeper portion of the bone is divided. This gives the wound in the bone when completed the wedge-shape which is believed by them to render correction of the deformity more satisfactory. This theoretical advantage does not seem to be altogether sustained by practical experience, and the change of instruments renders sepsis more possible.

Osteotomy is frequently required in cases of bow-legs. Sometimes it is necessary to divide both the tibia and the femur.

It requires from four to six weeks for the divided bone to unite after osteotomy for genu-valgum or genu-varum. After this time the gypsum dressing, which is usually applied over the antiseptic dressing immediately after the operation, may be removed. For a long time afterward apparatus is demanded in order that a recurrence of the deformity, or fracture of the bone at the point of operation, may not occur.

Various irregular deformities of the tibia may occur as a result of rickets. These may demand for their alleviation numerous osteotomies, or in some cases excision of a wedged-shaped piece of bone.

CHAPTER XXVI.

AMPUTATIONS.

Definition.—By amputation is meant the removal of a locomotor extremity of the body.

Varieties.—Amputations may be single, double, or multiple; partial or complete. Multiple when more than two extremities are removed at the same sitting. When two or more operators at once remove separate extremities the operation is termed synchronous amputation.

Complete when an entire extremity is removed, as the leg at the knee, termed complete amputation of the leg; or the thigh at the hip, known as complete removal of the thigh.

Partial when amputation is done within the extreme limits of an extremity. Thus, an operation removing but a portion of the forearm would be a partial amputation, but operation through the elbow-joint would be a complete amputation of the forearm. Amputations are sometimes spoken of as in contiguity or continuity; in contiguity when done between contiguous bones at joints, as amputations through the elbow-joint; and in continuity when division is made in the continuity of bones between joints, as in the middle of the thigh. Amputations may be natural, as those produced *in utero* by the umbilical cord or other constricting bands, or by the shedding of a part by gangrenous process; traumatic, as when an extremity is cut or torn off by machinery or projectiles; or as surgical premeditated scientific procedure.

Reamputations are either done subsequently to an unsuccessful amputation at a lower point, for disease of a stump, or to put into better shape the result of a natural or accidental amputation. The mere trimming-up of an extremity non-operatively removed should never be termed amputation or reamputation.

The objects of amputation are completely to rid the patient of a dangerous devitalized or impedimental extremity, which cannot otherwise be treated with beneficial results, and in so doing to leave him as useful a stump as possible. These being the objects of amputation it can readily be understood why with the advance of surgical knowledge the operation, especially for chronic disease and wound complications, is each year less frequently employed.

Indications.—Amputation may be indicated when an extremity has been hopelessly crushed, or, at a higher point, when an extremity has been avulsed or torn off; when the limb is destroyed by heat, frost-bite, or gangrene; for certain encircling and other incurable ulcers, and for morbid growths and deformities.

Contra-indications.—Amputations, unless extenuating circumstances are present, should not be undertaken when shock, nephritis, diabetes, pyemia, general tuberculosis, or atheromatous vessels are present. In spreading gangrene it will often be the patient's only chance for life, but in all other forms of the affection the operation should be delayed until a line of demarcation can be distinctly recognized.

Time for Amputations.—According to certain constitutional conditions which are present in cases demanding amputation the operation is termed (1) primary, (2) secondary, or (3) tertiary.

(1) Primary amputations are those which are performed for injury at once, or before septic absorption and consequent constitutional disturbance has taken place. The primary is the elective period if shock can be subdued, and the general condition of the patient warrants. When the injured part is kept aseptic the primary period can be indefinitely prolonged, but otherwise it will terminate in not less than twenty or more than forty-eight hours after injury, varying greatly with different individuals, the degree of shock, and the virulence of infection.

(2) Secondary or intermediary amputations are those performed while the septic process is developing and in active progress. This period usually begins from twenty-four to thirty-six hours after injury, its duration may be days, weeks, or months. There would be no secondary period following traumata if the wounds could be treated early enough and in thoroughly antiseptic manner. To the secondary period also belong all premeditated amputations for acute septic disorders, such as spreading gangrene, or abscess of a joint. Secondary amputations yield a very high death-rate, and should only be undertaken for such desperate circumstances as rapidly extending gangrene, or where it is thought to be a greater risk to allow the disorder to continue than to remove the extremity at so dangerous a time.

(3) Tertiary (chronic) amputations are those performed after the septic process has terminated or become chronic, and the patient well acclimatized to his altered state; also those performed for growths, simple aneurisms, chronic disease, deformities, and supernumerary extremities.

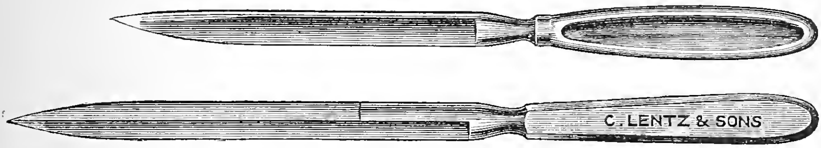
Location of Amputation.—The point at which amputation shall be made is determined by the nature and extent of injury; the presence of multiple fractures; of bloodvessel implication, and innumerable other circumstances which present with each individual case. But a good general rule is to amputate as far from the trunk as is consistent with thoroughness of removal, certainty of result, and subsequent utility of the stump. The mortality of amputations rises as the seat of operation approaches the trunk. In each extremity there are situations which, for various reasons, are more favorably regarded as *points of election* for amputations than others. Thus, the lower middle of the leg is the point of election for amputating the leg, because an artificial member can be best adjusted at that situation; amputation just far enough below the elbow to retain the tubercle of the radius, is vastly better than one through the joint, as in the former the power of flexing an artificial forearm is preserved. When operating for malignant disease, the site of amputation must widely clear the affected area, and, if bone is involved, the extremity should be removed at a point not lower than the first articulation above. Every possible atom of the hand is worth preserving, but no risk is worth taking to save toes or small portions of the foot.

The arm, forearm, thigh, and leg, are each divided into approximate thirds, that the seat of amputation may be more accurately described. Thus we speak of amputation in the lower third of the arm, the upper third of the leg, or the middle third of the forearm.

Instruments.—In addition to ordinary operating instruments, there will be required for amputations various special saws and knives, a double-edged knife (catlin) for dividing tissues between the bones of the forearm and leg, cutting pliers and bone forceps. Also tourniquets, the hemostatic

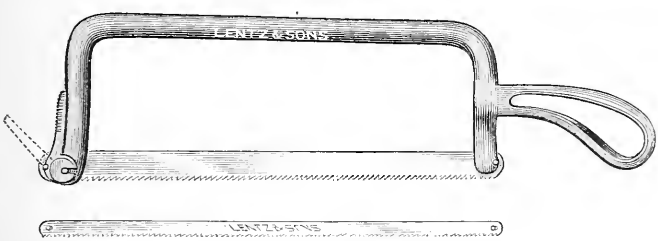
rubber bandage, and retractors for holding soft parts away from the saw. These latter are made from a stout piece of gauze six or eight inches wide and two feet long, torn through half its length into two tails, if but one bone is present, or into three tails if two bones are to be divided. It is applied in the latter case by covering each half of the divided tissues with the outside strips, and slipping the middle one between the bones; by traction upon the ends all tissues can then be drawn upward out of reach of the saw.

Fig. 475.



Amputating knife and catlin.

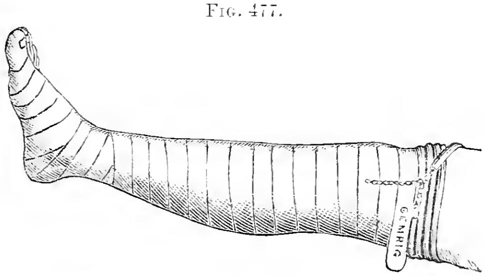
Fig. 476.



Aseptic amputation saw.

Operative Method.—Primary amputations will often be necessary when the patient's condition is far from favorable, but in tertiary operations we should get him into the very best general and local condition before operation is undertaken. In operating we should aim to sacrifice as little healthy tissue and lose as little blood as possible; to provide a sufficient bone covering; to divide bloodvessels and nerves transverely, and to insure thorough drainage and asepsis of the wound.

Fig. 477.



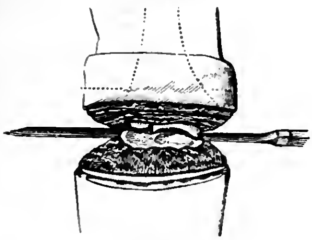
Esmarch's avascularization apparatus.

More or less complete avascularity should be secured by the rubber bandage, tourniquet, or other means, but only elevation and simple tourniquet should be employed when abscesses, gangrene, or malignant tumors are present, for fear of producing metastasis.

Incisions are generally made from above downward, and from without

inward to deep fascia, and the muscles divided at a higher point subsequently. But occasionally the method of transfixion, where the knife is carried directly through the centre of the limb, and the muscles and integument divided *en masse* as the knife is brought to the surface, may be employed with advantage. Incisions may be made in any manner or direction, provided that they yield a well-nourished covering for the end of the remaining portion of extremity. The coverings (the flaps) should be so devised and proportioned that there shall be no tension upon them, that they shall be well supplied with bloodvessels, and that when the wound has healed the resulting scar shall be neither over the bone end nor so placed as to interfere with the wearing of an artificial limb. Ordinarily, the number of flaps should not exceed two; but where there is extensive destruction of integument the surgeon may be driven to any kind of patchwork to provide sufficient covering for a stump, which otherwise must have been made much shorter. Extra length of flaps is of little consequence, for they can then be trimmed down, but the greatest precaution must be taken to have them not too short or narrow. A safe rule is to cut flaps so that their combined length is not less than two-thirds the circumference of the limb at the point of bone division. Their combined width should equal the circumference at that point. They may be cut of equal size, or one long and the other short, in varying degree; antero-posterior or lateral; simply cutaneous or musculo-cutaneous.

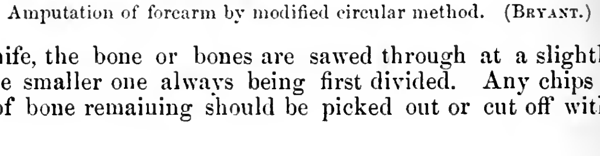
FIG. 478.



Amputation through elbow-joint by circular method.

When amputation is made by circular incision (the so-called circular method) the skin of the extremity is grasped by the left hand, drawn upward, and steadied, while the right hand holding a long amputating knife is passed around the limb until the surgeon looks upon its dorsal surface. The heel of the knife is then sunk through the integument, and as the hand is brought back around the limb the incision is completed. A cuff of integument is then dissected up and turned back to the proper distance to make a sufficient flap. All flap dissections in amputations should be done with the knife edge directed toward the muscles, that the bloodvessels of the skin may be least injured. The muscles are then divided to the bone by a similar circular sweep immediately below the point up to which the flaps have been dissected, the retractor is applied, and any interosseous tissue having been previously divided with a double-

FIG. 479.



Amputation of forearm by modified circular method. (BRYANT.)

edged knife, the bone or bones are sawed through at a slightly higher level; the smaller one always being first divided. Any chips or sharp spicules of bone remaining should be picked out or cut off with forceps

and the bone ends left smooth. Some surgeons prefer to cut the muscles at once down to periosteum rather than to cut the membrane at a lower point and scrape it upward as a flap for the bone end, but I consider this as of trivial importance. The removed part is then placed in a suitable receptacle, the sawdust washed away with a stream of bichloride solution and all attention given to seeking and tying the arteries. This accomplished, any redundant muscle or flap is cut away, the ends of tendons and nerves drawn down and cut off, and the tourniquet loosened. Every bleeding point should be separately grasped by forceps or tenaculum and tied with catgut. Extensive or continued oozing can be controlled by very hot water or alcohol applications. Bleeding from the bone medulla should be arrested by the same means, pressure of a finger, packing with catgut, or the cautery.

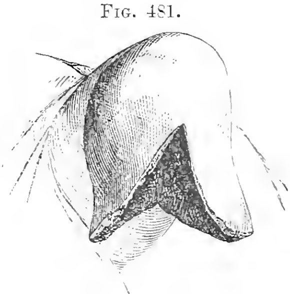
Fig. 480.

Stump; showing application of sutures and drain-tubes. A drainage-tube is shown at the left. (Smith.)

The flaps are now approximated over a sufficient drain by catgut sutures and the dressing applied. Two flaps may be made after circular incision by a vertical incision on each side (modified circular method). When thus made the square corners of the flap should be rounded off. Amputation by circular incision is only applicable to the arm and forearm.

The more usual method of amputation is that by double cutaneous or musculo-cutaneous flaps, made almost square with round corners, exactly rectangular, or oval. These are made usually by incision from above downward and from without inward, but may also—that is, the musculo-cutaneous—be made by transfixion. Cutaneous flaps with circular division of muscles are generally best. Excepting in shape of flaps the cutaneous method is identical with that of circular incision. So, also, the partially musculo-cutaneous in which the muscles are similarly divided, but at a point somewhat below the origin of the flaps. Musculo-cutaneous flaps are made by transfixion, but can be imitated by cutting the muscles

Fig. 481.

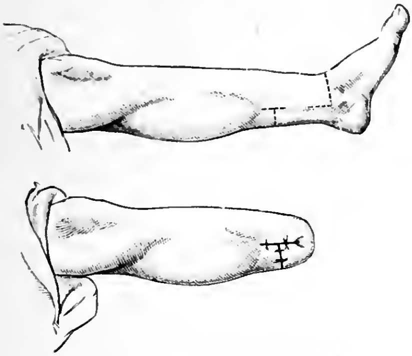


Amputation by lateral flaps.

obliquely to the bone in the lines of flap incision. The latter are not popular or to be recommended, however, as they provide too voluminous a stump and divide bloodvessels obliquely, or may notch them at a point above where the ligature will be applied.

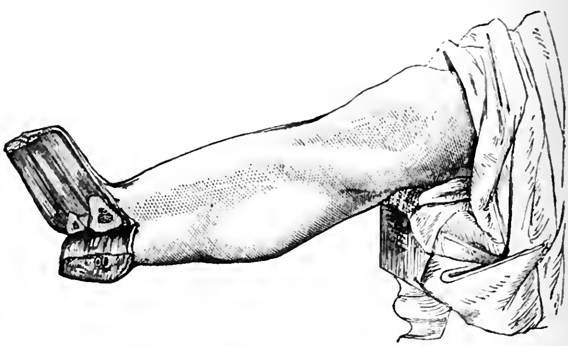
TEALE'S METHOD of amputating consists in making two exactly rectangular musculo-cutaneous flaps: a long one, half the circumference of the limb at the point of bone division and a short one, half the length of the long one, or one-fourth the circumference of the member. In the typical Teale operation the long flap is taken from the anterior surface and forms the bone covering, while the shorter one is made upon the posterior surface, and contains the principal bloodvessels. Each flap is exactly half the circumference of the limb in width. But practically the flaps can be taken from any opposite sides, and can be altered in length without materially interfering with the excellent stump which almost invariably results. Many surgeons of experience omit measurements and approximate the dimensions of the flap by the eye, but usually careful measurement and marking out with indelible pencil or nitrate of silver should be done previous to operation. Teale's amputation is especially fit for the forearm and leg, but may be adapted to the arm and thigh with success. The sole objection to it is that sometimes more of the member must be sacrificed by it than by other forms of amputation.

FIG. 482.



Amputation by Teale's method.

FIG. 483.



Teale's amputation; completed flaps. (TEALE.)

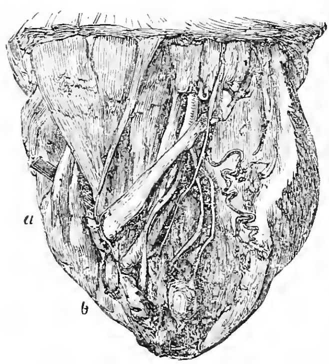
AFTER-TREATMENT.—Happily, in these days of aseptic wounds, the after-treatment of amputation wounds has become almost trivial, unless by accident infection has taken place. Ordinarily, even largest stumps need not be redressed for from two weeks (when rubber drains should be removed) to a month. They should simply be kept quiet and somewhat

elevated. In amputations of the leg or thigh the patient should be kept in bed at for least three weeks, but in removal of upper extremities he may usually be up much earlier. Antiseptic dressings should be kept applied until even the drain sinuses have finally closed.

Affections of Stumps.—If by the temperature record, pain, etc., it becomes apparent that the wound is septic, the dressing should forthwith be removed, all tension relieved by dividing sutures, the wound cavity thoroughly washed out with antiseptic solution, perhaps more drain tubes put in, and the dressing reapplied, or the extremity put under antiseptic continuous irrigation. If abscesses form they should at once be opened, curetted, and drained. Severe infection of an amputation wound would call for re-opening, curetting, washing and dressing as a fresh wound. Tissues and flaps appearing unharmed at the time of operation may subsequently slough, and require either skin grafting or re-amputation. Spreading or recurring gangrene imperatively indicates removal of the remaining portion of the extremity at either its junction with the trunk or at a point well beyond the affected area. Secondary hemorrhage in aseptic stumps is exceedingly rare. If moderate pressure by bandages and pressure upon the artery of supply do not speedily check it, the wound must be opened and the offending vessel tied.

Bones in stumps may be fractured by traumatism, and should be treated upon the general principles elsewhere dwelt upon, or the fragment may be excised. Osteomyelitis continuing or developing in the bones of stumps should be treated by prompt re-amputation not lower than through the first joint above.

Fig. 484.



Neuromata in stump. Large neuromatous mass at a; opposite b the tumors are more defined. (Miller.)

Aneurismal tumors or varices should be treated by excision of the vessel mass. Bulbous neuromata, which occasionally develop upon the cut nerve-ends and give rise to intense suffering, should be excised, or, this failing, the supplying nerves should be stretched or cut at a higher point. So also should be treated neuralgias due to entanglement of nerve fibres in the cicatrix.

Occasionally great harm is done to a stump, or the life of the patient even endangered, by intense muscular twitchings, or the presence of actual chorea in the extremity. Extension of the stump, combined with tight temporary bandaging of the muscles, sedatives, antispasmodics, and removal of irritating causes usually suffice for perfect relief, but an occasional rare case will baffle all remedial efforts.

Because of poor surgery, or of unavoidable subsequent sloughing, the flaps or cicatricial tissue may be drawn tightly over the bone end, which may even come directly out, producing a typical form of what is called "conical stump." Removal of more bone, or re-amputation at a higher point, will alone answer for the relief of this condition.

Chronic ulcers, eczema, or epitheliomata may develop in and about the cicatrix, and require its excision or a re-amputation.

As in all aseptic wounds, tetanus is unheard of in properly-treated

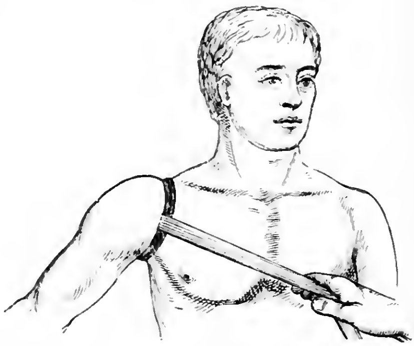
amputations. Its development would be an indication of infection and demand exploration of the wound.

Special Amputations.

Amputation through Shoulder-joint.

Hemorrhage is prevented by a rubber band tourniquet passed through the axilla across the spine of the scapula and tied tightly down upon the acromial end of the clavicle; by pressure of the thumb or a padded key in the post-clavicular fossa, thereby compressing the subclavian artery upon the first rib; or, perhaps best, by having an assistant compress the axillary vessel in the flap before it is finally severed. A primary incision is made by splitting the deltoid into equal parts from its origin to insertion, and

Fig. 485.

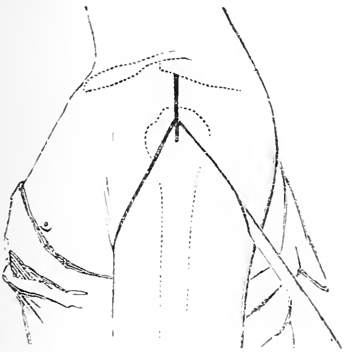


Application of Esmarch's tourniquet in amputation through shoulder-joint. (Smith.)

carried down to the bone throughout; that is, from the acromion process of the scapula directly downward for about three inches. Subsequent incisions are carried from the base of this one in a slightly oblique and downward direction to the anterior and posterior borders of the axilla, being careful not to prolong either incision so far as to threaten the axillary artery. The two lateral flaps thus made are then dissected up and freed from the bone; the capsule is widely incised; the long head of the biceps divided close to its insertion; the attachments of the humeral tuberosities divided after being made tense by inward and outward rotation of the arm, and the bone exarticulated by drawing the elbow across the chest toward the opposite side. A trustworthy assistant now compresses the axillary artery high up in the flap, the remaining bridge of tissue containing the vessel is divided at a lower point, and the extremity removed. With perhaps more certainty of avoiding loss of blood, particularly in absence of a competent assistant, a tourniquet can be applied to the arm high up and a circular amputation done at the insertion of the deltoid muscle. The arteries are then secured, and an incision made slitting the deltoid as before described, through which the remaining portion of the bone is excised. If the tissues of the axilla are much injured, a single large flap can be taken from the outer aspect of the member,

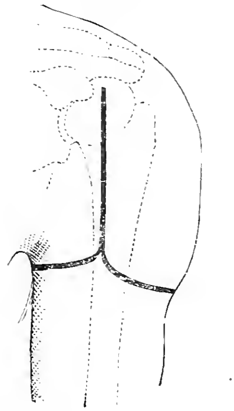
including the entire deltoid, or, *vice versa*, a flap from the inner aspect can be made to cover in the wound.

Fig. 486.



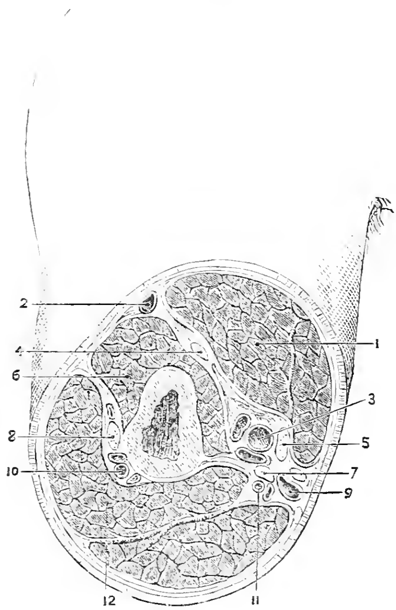
Amputation through shoulder-joint. Lines of incision (usual or oval method). (Liston.)

Fig. 487.



Amputation through shoulder-joint. Lines of incision for modified oval method. (Smith.)

Fig. 488.



Section through the middle of right arm. (Heath, from Béraud.) 1, biceps; 2, cephalic vein; 3, brachial vessels; 4, musculo-cutaneous nerve; 5, median nerve; 6, brachialis anticus; 7, ulnar nerve; 8, musculo-spiral nerve; 9, basilic vein with internal cutaneous nerves; 10, superior profunda vessels; 11, inferior profunda vessels; 12, triceps with intra-muscular aponeurosis.

Amputation of the Arm.

Amputation of the arm can be accomplished by double flaps from any opposite aspects of the member, or by the single flap, the circular, or Teale methods. The deltoid attachments should be retained if possible in high amputations. Operation by internal and external flaps, the former a little longer than the latter, or the formal Teale, are usually more satisfactory. The member should be removed at as low a point as is compatible with vitality of the flaps.

Amputation through the Elbow-joint.

This is best done by antero-posterior rectangular or elliptical flaps, the resulting stump being a most useful one, but nothing to compare with that of removal a short distance below the joint, whereby the insertions of the biceps and triceps muscles are preserved. The forearm being supinated, incisions are made from the condyles of the humerus down to and along the radius and ulna respectively for a distance of about four inches, and their lower extremities are connected anteriorly by a third transverse incision. The fleshy flap included between the incisions is dissected up, keeping close to the bones, until the level of the condyles is reached. Another incision is now made directly across the back of the articulation down to the bone connecting with the primary incision on each side. The knife is then passed between the head of the radius and the humerus, and down through the joint, dividing the lateral ligaments; after which the olecranon is either detached from its biceps attachments, or else sawn through from above downward directly above the coronoid process. If the latter portion of bone is uninjured it is better to allow it to remain, as thereby the triceps insertion is preserved and a more serviceable stump secured. The ends of the flap are first sutured and then the sides.

Amputation of the Forearm.

This may be done by the Teale or circular methods or by any other variety of flaps. If no extra length is thereby sacrificed, the Teale operation should hold preference over all others. The upper portion of the lower third of the member would be the point of election. Any projecting tendon ends should be well drawn down and cut off. Care must be taken to ligate securely the inter-osseous artery.

Amputation through the Wrist-joint.

This is performed by securing a large fleshy flap from the palm and a smaller one from the dorsum of the hand. These may be either rectangular or oval, but the nature of injury may compel the use of other shapes or kind of flaps. Here, likewise, tendon ends must be drawn down and cut off.

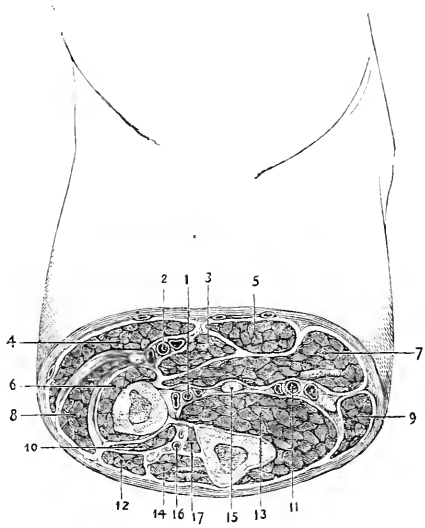
Inter-carpal and Carpo-metacarpal Amputations.

Inter-carpal and carpo-metacarpal amputations are never performed, as they make useless and impedimental stumps, to which prothetic apparatus cannot be adjusted.

Amputation of the Hand.

Amputation of the hand through the metacarpal bones may sometimes be done and a very useful stump secured. Oval or rectangular antero-posterior flaps should be employed. Amputations through one, two, or three metacarpals are done in a similar manner.

Fig. 489.



Section through the middle of the right forearm. (Heath, altered from Béraud.) 1, anterior interosseous vessels and nerve; 2, radial vessels and nerve; 3, pronator teres; 4, supinator longus; 5, flexor carpi radialis; 6, supinator brevis; 7, flexor sublimis digitorum; 8, extensores carpi radialis longior and brevior; 9, flexor carpi ulnaris; 10, extensor ossis metacarpi pollicis: 11, ulnar vessels and nerve; 12, extensor communis digitorum; 13, flexor profundus digitorum; 14, extensor carpi ulnaris; 15, median nerve; 16, posterior interosseous vessels and nerve; 17, extensor secundi internodii pollicis.

Amputation through the Metacarpal Phalangeal Articulation.

Four fingers can be removed by antero-posterior flaps; two by oval incision, entering the knife half an inch above the knuckle and cutting downward around one side of one finger across the palm beneath both and up the opposite side of the second finger to the point of origin, and one finger by the same shape of incision, but limited to a single digit. If strength of hand is desired the heads of the metacarpal bones should not be disturbed, but if appearances alone are to be considered they should be cut off by cutting pliers.

Amputation of the Thumb.

This is effected by an oval incision. The knife is entered just above the articulation and carried down along the upper surface of the metacarpal bone until its centre is reached, when it diverges, encircles the extremity

just above the first inter-phalangeal joint, and again joins the primary incision. Amputation of the thumb through its metacarpal bone may also be made by oval incision, the point of the oval being directly over

FIG. 490.

Removal of head of metacarpal bone. (DRUITT.)

FIG. 491.

Amputation of thumb with its metacarpal bone. Line of incision. (DRUITT.)

the bone just above the point where it is to be divided, which latter is accomplished by strong cutting pliers. Amputation through the corresponding bone or joint of the little finger is executed by analogous procedures at its carpo-metacarpal junction.

Amputation of Phalanges of Hand.

This is done either through the bone by antero-posterior or other incisions, or through inter-phalangeal joints. In doing the latter operation it is well to make a short anterior flap and a large posterior one from the belly of the digit. The joint can always be opened readily by flexing the finger and pressing the knife just below the head of the proximal bone. Occasionally no anterior flap is made, but the knife is at once pressed through the joint, and a large posterior flap cut as it is withdrawn after passing through the joint. Ligatures are never required in finger amputations; sutures including the vessels can be made to control all hemorrhage. Drainage, as a rule, is not necessary. An India-rubber umbrella-ring answers well as a tourniquet.

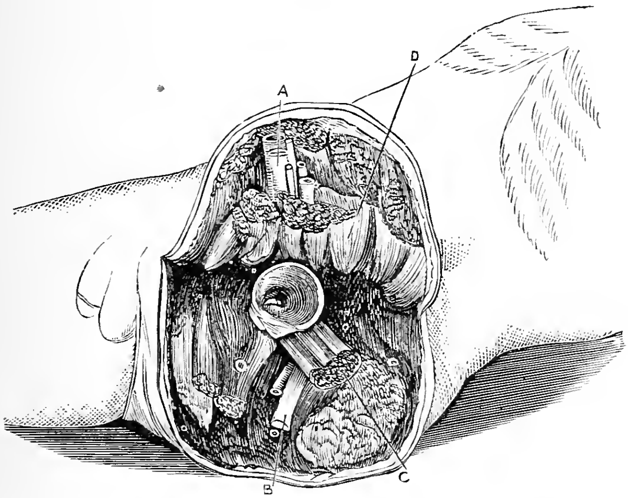
Amputation through the Hip-joint.

This is a dangerous and formidable operation, owing to the great primary and subsequent shock, which an operation so near the trunk dividing such huge vessels and nerves must necessarily involve.

The death-rate of tertiary operations is high; that of primary operations exceedingly so. The limb having been rendered avascular by elevation or rubber bandage, infinite care must be observed to prevent undue hemorrhage. This can be done (1) by digital pressure upon the femoral artery as it passes under Poupart's ligament; (2) by compression of the corresponding iliac artery against the ilium by the fingers of a small hand introduced into the rectum; or (3), by preliminary ligation of the femoral just beneath Poupart's ligament. Abdominal tourniquets are unnecessary

and undesirable. The above methods of controlling hemorrhage apply only to the older methods of making large antero-posterior flaps by transfixion or otherwise. The nature of injury or disease may occasionally render amputation by those methods necessary. The scrotum being held out of the way, the sound leg well abducted, and the diseased thigh having been slightly bent to slacken the anterior muscles and abducted, an

FIG. 492.



Amputation through hip-joint by long anterior and short posterior flaps. *A*. The femoral and profunda vessels, with branches of anterior crural nerve. *B*. The great sciatic nerve and its companion artery and branch. *C*. Muscular mass from tuber ischii and obturator externus muscle, with large branches from profunda and gluteal arteries on either side. *D*. The psoas and other muscles immediately in front of the joint. (HOLMES.)

eighth-inch knife is entered just above the centre of the space between the anterior superior spine of the ilium and the great trochanter; is pushed obliquely downward and inward until the joint is touched; the handle is then depressed until the knife point slips across the joint (thereby opening up the capsule), when it is raised again and the point pushed on until it emerges just in advance of the tuber ischii. By a downward, and, finally, outward sawing motion, a large anterior flap is formed as the knife is brought to the surface. Just before the outward stroke is made, an assistant controls the femoral by grasping it firmly in the upper portion of the flap. This vessel is then securely ligated; the flap is held up, and, the thigh being rotated inward, the muscular attachments of the great trochanter are divided. The limb is now hyper-extended and adducted, thereby accomplishing exarticulation, while the knife continues its downward course and cuts a fleshy posterior flap. Or, a large anterior cutaneous flap may be cut from without inward in the same lines as above, the vessels isolated and tied in continuity, and then a division of the muscles made down to and opening the joint, but below the point of ligation; the subsequent steps being identical with the first described method. But for chronic cases where the parts are much wasted, or where every particle

of blood is of great importance, a more recent procedure (Forneaux-Jordan method) is by far the best. This may be performed in several ways:

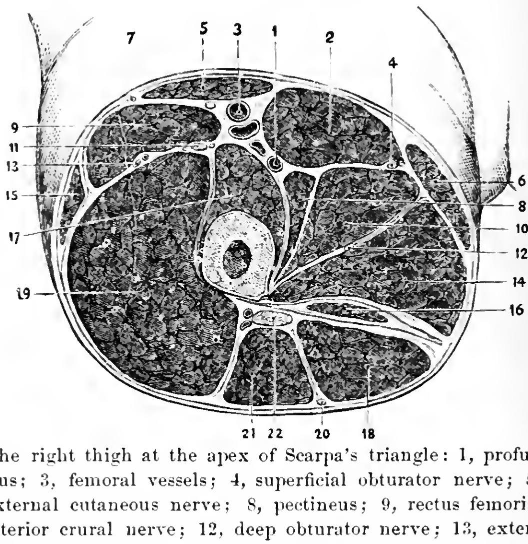
1. A tourniquet is placed upon the highest situation of the thigh possible. A circular division of integument and muscles to the bone is then made by a single sweep immediately below the tourniquet, the bone divided, and all vessels secured as in a thigh amputation. These having been ligated, a second incision is made from just above the great trochanter downward until it runs at a right angle into the first. The attachments of the trochanter are divided, the joint opened, the remainder of the femur carefully dissected out, and the flaps sutured.

2. The vessels can be ligated after the circular incision without sawing the bone, which is removed entire through the second incision.

3. The operation may be done by oval or racket-shaped incision, precisely the same as amputation of the shoulder is performed. The downward straight incision is made from the trochanter, and from its lower extremity branches diverge forward and backward, concave downward, terminating just before reaching the femoral vessels. The flaps thus formed are separated from bone, and exarticulation is accomplished. Finally, after an assistant grasps the vessel in it, the remaining bridge of integument and tissue is divided and the vessels ligated. No tourniquet is here required.

The hip may also be exarticulated by simple large antero-posterior musculo-cutaneous flaps cut from above obliquely downward and upward toward the joint. In this case the posterior flap should be made first, and its vessels secured by forceps or ligatures before the anterior flap is commenced. A large, flat, hot sponge pressed upon the cut surface may answer temporarily for this purpose, however.

Fig. 493.



Section of the right thigh at the apex of Scarpa's triangle: 1, profunda vessels; 2, adductor longus; 3, femoral vessels; 4, superficial obturator nerve; 5, sartorius; 6, gracilis; 7, external cutaneous nerve; 8, pectineus; 9, rectus femoris; 10, adductor brevis; 11, anterior crural nerve; 12, deep obturator nerve; 13, external circumflex vessels; 14, adductor magnus; 15, tensor vagina femoris; 16, semi-membranosus; 17, vastus internus and crureus; 19, semi-tendinosus; 19, vastus externus; 20, small sciatic nerve; 21, biceps femoris; 22, great sciatic nerve. (Heath.)

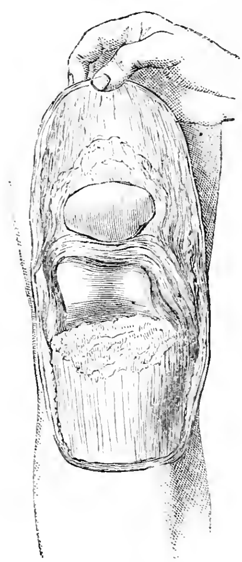
Amputation of the Thigh.

This may be accomplished by ordinary flaps, antero-posterior or lateral, or by the typical or modified Teale method. The latter is best when it does not sacrifice length unduly.

Amputation through the Knee-joint.

This makes an excellent and serviceable stump. It may be done by a large anterior flap, including the patella, and a short posterior one from the fleshy portion of the upper calf. The former is cut from above downward to bone, and dissected up above the condyles of the femur. The knife is then sunk through the joint as it is held flexed, and the posterior flap is made as it is brought to the surface through the subjacent tissues. The operation may also be performed by lateral, single anterior, or single posterior flaps, but, as a rule, not with so great success. If the patella is diseased or badly injured, it should be dissected from the flap. If the uninjured integument is not sufficient to cover the condyles, more or less of the latter must be sawn off, and, if the patella is left in, its under surface should be removed until cancellous structure is exposed, when it may be nailed or sutured to the sawn femoral end, and there expected to unite. If in so doing the quadriceps tendon is made taut, it should be divided from the under surface of the flap. This may occasionally be necessary in any case.

Fig. 494.



Amputation through knee-joint by long anterior flap. (Erichsen.)

Amputation of the Leg.

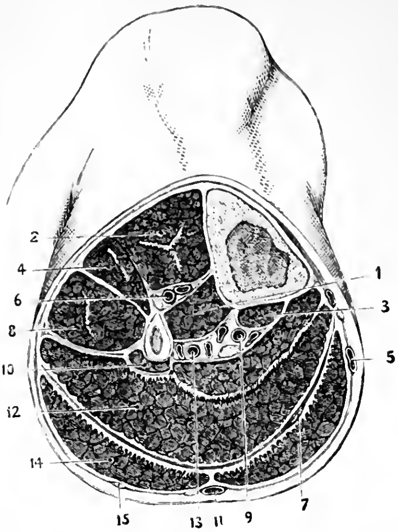
This should never be performed below the centre of the limb, nor in close proximity to the knee-joint; such removals result in worse than useless stumps upon which prothetic apparatus cannot be placed. The point of election is the junction of the upper and middle thirds. The Teale method here finds an ideal application and result, but good results can also be obtained by almost any variety or combination of flaps. After sawing the bones the sharp upper edge of the tibia should be sawn off obliquely, that it may not subsequently press upon the, at that point, necessarily thin flap.

Amputation through the Ankle-joint.

This is not favorably regarded by most surgeons, because of the numerous failures caused by sloughing of flaps. No amputation at this point is justifiable unless a well-nourished single flap from the heel (Syme's method) can be obtained. And it is the death of this very flap which has required so many re-amputations in this situation and brought the

operation into discredit. But a more clear understanding of the nutrient supply of the heel and its surroundings has again revived this operation

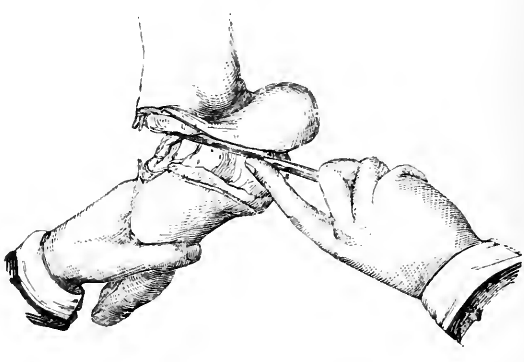
Fig. 495.



A section of the right leg in the upper third. (Heath, from Béraud.) 1. Tibialis posticus; 2. Tibialis anticus; 3. Flexor longus digitorum; 4. Extensor longus digitorum; 5. Internal saphenous vein; 6. Anterior tibial vessels and nerve; 7. Tendon of Plantaris; 8. Peroneus longus; 10. Flexor longus pollicis; 11. External saphenous vein and nerve; 12. Soleus with fibrous intersection; 13. Peroneal vessels; 14. Gastrocnemius (outer half); 15. Communicans peronei nerve.

which, when successful, is eminently so. The foot is flexed to a right angle, and from the centre of the internal malleolus an incision is carried

Fig. 496.



Amputation through ankle-joint. Syme's method. (Skey.)

down to the bone directly across the sole to a point over one-fourth of an inch in advance of the external malleolus. The extremities of this

incision are then connected by a second, also carried down to the bone, arching sharply upward across the dorsal surface of the ankle. Next the foot is forcibly flexed and the ankle-joint opened through the upper incision. The lateral ligaments are divided and, the foot being still flexed, the attachments of the astragalus and calcaneum are carefully dissected off, the point and edge of the knife being kept toward the bones. Especially must caution be observed in dissecting about the lesser tuberosity of the os calcis and inner portions of the ankle, that the vessels there situated, and upon which the life of the flap mostly depends, may not be injured. Finally, the dissection reaches the insertion of the tendo Achillis. This is separated and the removal completed. The malleoli and a thin slice of articular cartilage are then sawn from the tibia and fibula, and, after tendon ends are retracted, the flaps are sutured.

Pirogoff's amputation differs from the above in that, by this method, a portion of the calcaneum is allowed to remain and is brought into contact with the sawn ends of the tibia and fibula, where it usually unites by bony union and makes a capital stump. The incisions are as above described, except that the lower one in crossing the sole is carried from one-half to three-quarters of an inch nearer the tip of the heel, nor by

FIG. 497.

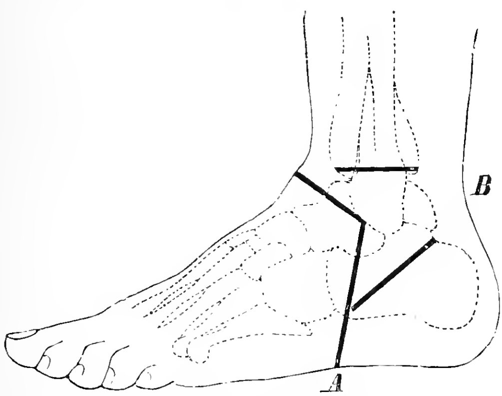


Diagram of cutaneous incision on outer side (*A*), and lines of section of the bones (*B*) in Pirogoff's amputation. (STIMSON.)

the same distance does the dorsal incision ascend the ankle. Each flap having been dissected up about half an inch the joint is opened from above. The foot being strongly flexed the astragalus is shot forward from between the malleoli. Behind the astragalus is then inserted a narrow-bladed saw and the os calcis sawn through in a direction obliquely downward and forward. The soft parts are then dissected from the malleoli, and so much of the latter is removed as to expose the cancellar tissue of both leg bones. The flaps are then sutured, bringing the two sawn surfaces in contact, where they are secured by a nail or two driven through the flaps. Bony union is usual. Possibly the tendo Achillis may require division. Pirogoff's method affords a better, more useful and solid stump, and with less shortening of the limb and liability of reamputation than when the Syme operation is employed. A good result, including ankle-joint motion, can also be obtained by leaving the astragalus *in situ*, sawing off its under surface and bringing the divided portion of the calcaneum

into contact with it. Syme's method may be modified so as to leave the astragalus in position.

FIG. 498.

Pirogoff's amputation. Lines of incision. (ERICHSEN.)

Amputation through the Medio-tarsal Joint. (Chopart's.)

An incision is made across the dorsum of the foot, convex downward, from midway between the external malleolus and the tuberosity of the fifth metatarsal bone to a point just behind the prominence of the scaphoid. The extremities of this incision are carried vertically downward well into

FIG. 499.

Stump after Pirogoff amputation. (ERICHSEN.)

FIG. 500.

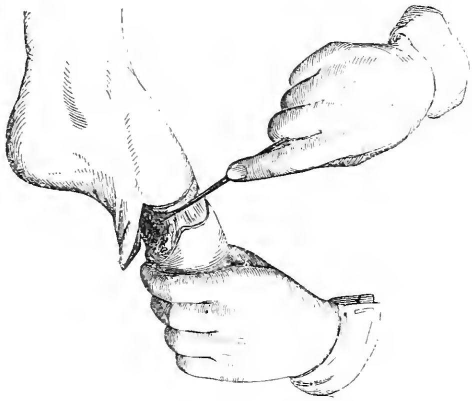
Amputation through medio-tarsal joint. (BRYANT.)

the ball of the foot, where these incisions are connected by a fourth crossing the plantar surface. A fleshy plantar flap is then dissected up; the foot forcibly pressed down, and disarticulation effected at the medio-tarsal junction. Division of the tendo Achillis to prevent subsequent contraction of the flaps is expedient. The scaphoid bone is occasionally, by accident, left behind, but gives rise to no inconvenience.

Amputation through the Tarso-metatarsal Joint. (Lisfranc's.)

In this operation a transverse dorsal incision, convex downward, runs from the tuberosity of the fifth metatarsal bone. A plantar flap is made as in medio-tarsal amputation. The foot being pressed down, the three outer and the first metatarsal bones are separated from the tarsus. Then the second metatarsal (which projects into the space between the internal

Fig. 501.



Amputation through the tarso-metatarsal joint. (Skey.)

and external cuneiform bones) is likewise separated by driving the point of the knife between it and the internal cuneiform, and, the foot being forcibly everted, carrying it around the joint. Or, to avoid this latter difficulty, the end of the second may be sawn off and left *in situ* after the other metatarsals have been exarticulated (Hey's amputation).

Amputation through the Metatarsus.

Amputation through the metatarsus, or metatarso-phalangeal junction, as a whole, is accomplished by taking a short flap from above and a longer fleshy one from the ball of the foot.

Amputations of the great or small toes at their metatarso-tarsal articulation, also of one or more toes at the metatarso-phalangeal junctions, are accomplished by the same racket-shaped incision method by which analogous portions of the hand are removed. Amputations through the interphalangeal toe-joints is performed by antero posterior or lateral square or oval flaps. Amputation of toe phalanges should always be done through a joint.

CHAPTER XXVII.

DISEASES OF THE MAMMARY GLANDS.

Neuroses.

Mammary Neuralgia.

Neuralgia of the mammary glands is found especially in young women, and is often associated with some ovarian or uterine difficulty. Hyperæsthesia is often excessive, so that the mere contact of the clothing gives rise to great pain. A similar neuralgic condition is at times found as an accompaniment of small benign tumors of the breast or of chronic mammary inflammation. It is often difficult to correct this condition because of the nervous element involved. If the surgeon can discover the cause of the nervous strain and remove it the disease will disappear entirely. The fear felt by the patient that the condition is one of malignant disease must be dispelled, as it has a tendency to increase the pain. It should be recollected also that this affection, which is one of no vital importance, is more painful than are malignant growths in their early stages. At times there is a slight serous or blood-stained discharge from the nipple when the mastodynia or neuralgia of the breast accompanies a localized chronic inflammation.

Treatment.—The treatment consists in assuring the patient of the innocent character of the disease; in distracting attention from the mammary region; in relieving the source of the nervous wear and tear; and in giving mental occupation of an agreeable nature. Valerianate of zinc, iron preparations, and other tonics are the remedies indicated; in fact, the line of treatment is that to be followed in cases of hysteria. If there be any small inflammatory nodules within the breast it is proper to remove them if the patient's anxiety is great enough to warrant such a slight operative procedure. If the surgeon is in doubt as to the character of these hardened tissues, operation is valuable by enabling him to clear up the diagnosis. The question of malignancy can then be definitely settled by the microscope.

Inflammation of the Breast.

Pathology.—Inflammation of the mammary glands, called mastitis or mammitis, may be acute or chronic. In the former condition, suppuration, causing what is termed mammary abscess, may occur. This is very unusual, however, excepting during lactation. The so-called cold abscess, due to the tubercle bacillus, is rare, but may occur. Acute mastitis arises occasionally as a complication of mumps, just as in the male we find orchitis arising secondary to that inflammation of the parotid gland. Acute inflammation of the breast, not connected with pregnancy and lactation, is similar to the condition occurring as a complication of parotitis, and needs no special mention. Puerperal mastitis occurs more commonly in primi-

paræ, and during the first three or four weeks of nursing, although it may occur at the end of many months of suckling. It is not usual in mothers who bring up their children by artificial feeding. The causes are over-distention of the milk-ducts because there is more milk secreted than can be drawn from the glands by the child, and sore nipples. In instances of fissured or otherwise irritated nipples, the child is unable freely to empty the breast, and by its efforts causes still further irritation of the inflamed tissue. The inflammation so caused at the nipple travels along the lymphatics into the interior of the breast, and adds, therefore, its irritative influence to that due to distention of the milk-ducts from retained lacteal secretion. The probability of microbic infection through fissures of the nipple, especially when absolute cleanliness is not observed, is easily understood. It is probable that freely washing the surface after nursing with some form of non-poisonous antiseptic would prevent many cases of mastitis.

Symptoms.—Acute mammitis begins, as a rule, with a chilly sensation, fever, headache, and local soreness of the breast, followed by heavy, aching sensation, with throbbing. Upon manipulation, the organ feels hard and knotty in spots, because inflammation usually affects a few, not all, of the lobules of the gland. As the disease progresses the whole breast becomes swollen and hard, and the skin tense, shining, and livid. If suppuration occurs it is usually preceded by a chill, after which the skin becomes œdematous. Soon there is evidence of pointing, and the pus is finally evacuated spontaneously if the abscess is not opened by the surgeon's knife.

Treatment.—The treatment should be physical and functional rest. The former is obtained by keeping the patient quiet, with the arm supported in a sling, and the breast held up against the thorax by a closely fitting bandage. Functional rest is obtained, if the case is a puerperal one, by preventing the child nursing. It is important that neither breast be used for suckling. If the secretion of milk continues and causes pain by distention, it is necessary to empty both glands by means of a breast-pump carefully applied. Leeches may be used in persons of vigorous health, and should be applied below the breast rather than above it. Purgatives and antiphlogistic remedies are indicated in cases of sthenic type, but if the patient is debilitated, tonic rather than depressing remedies should be prescribed. Hot-water fomentations, applied by means of a conical sponge laid over the breast several times a day, will often be a great comfort to the patient. An antiseptic dressing covered with rubber tissue to prevent evaporation, makes a good emollient dressing. The extract of belladonna made into a paste with a little water, and spread upon the surface of the breast, lessens the pain and may aid in diminishing the secretion of milk. Lotions of lead-water and laudanum are at times serviceable. Some surgeons believe that the application of ice-bags is good practice. In some cases inflammation subsides by resolution, and after two weeks' time the patient may resume nursing. If suppuration occurs, free incision and curetting must be adopted at a very early period. This will be discussed under abscesses of the breast. Acute mastitis may run on to a stage of chronic inflammation, which must be managed in the same manner as cases which assume a chronic type from the beginning.

Chronic Inflammation of the Breast.

Pathology and Symptoms.—Chronic inflammation of the breast usually attacks only one, two, or three lobules of the gland and exhibits itself as a hard, irregular mass accompanied by a moderate degree of pain. The process is a sort of cirrhosis. The inflammatory process involves the connective tissue, which becomes increased in amount and compresses the glandular structure of the breast until it becomes more or less atrophied. Since the whole gland is not affected, there is a certain resemblance between this lobular mastitis and carcinoma, because in each case there is no sharp outline felt between the growth and the normal gland, and because the two conditions are most common about the menopause. The points of diagnosis are that the inflammatory induration is not as hard as carcinoma; the integument is not adherent to the mass nor dimpled by it. Moreover, carcinoma is apt to attack single portions of the breast, whereas inflammatory involvement of two or three lobules is not uncommon. Again, the inflammatory condition may be found in both breasts at the same time; this condition is exceedingly rare in carcinoma. Retraction of the nipple, which occurs in carcinoma situated directly below the nipple, does not occur in inflammation. There is slight probability of inflammation being followed by involvement of the axillary lymphatic glands, but such involvement is common in carcinoma. Chronic mastitis is also differentiated from carcinoma by the fact that it improves under treatment. Non-malignant tumors of the breast are diagnosticated from chronic mastitis by being more defined in outline.

Treatment.—The treatment of chronic mastitis is carried out by hot-water applications made by means of a conical sponge laid upon the breast two or three times a day; by anointing the skin with oleate of mercury ointment (about 10 per cent.); or by using some form of counter-irritation such as is obtained by painting the parts with tincture of iodine, or by the application of a blister. Pressure should be made upon the diseased gland by covering it with cotton wadding and carrying a bandage of elastic webbing around the chest so as to support and press the gland against the ribs. The turns of the bandage should be started below the breast and carried upward. Friction, or pressure by corsets or other articles of clothing, should be prevented. The arm should be kept quiet as much as possible, or carried in a sling. The support of the breast, associated with equable pressure, is probably the most important part of the treatment. Potassium iodide may be given internally as an absorbifacient. This line of treatment should be continued for months, since improvement is usually slow.

Abscesses of the Breast.

Pathology.—Suppuration may occur between the breast and the skin, within the gland itself, or between the gland and the pectoral muscle. The first condition is called supra-mammary abscess; the second mammary abscess; the third, sub-mammary abscess. It is possible also to have tubercular disease of the breast causing the so-called "cold abscess." Acute abscess of the breast is due here, as in all other places, to the entrance of pyogenic bacteria, which gain admission, probably, through the ducts of the nipple, or through fissures of the nipple or integument.

Supra-mammary abscess presents no special symptoms needing description.

Abscesses behind the breast push the breast forward, giving it a very conical appearance. The pus may, after a period of protracted suffering, burrow beneath the breast and finally cause a spontaneous opening at the circumference of the gland, or even near the axilla. Occasionally, evacuation occurs through the substance of the gland.

Mammary abscess may occur at several points and riddle the breast with pus pockets and sinuses. If operative evacuation is to be done, it should be undertaken at an early period.

Suppurative mastitis is an affection causing great pain and exhaustion, and is usually found during lactation. Abscesses in connection with the mammary glands may also be the result of necrosis of the underlying rib, or may be due to spontaneous opening through the chest wall of a pulmonary abscess or suppurative pleurisy.

Treatment.—The measures to be employed in acute, non-suppurative mastitis have been discussed under the treatment of that affection. When pus has evidently formed, it should be evacuated by one or more free incisions; after which the pus cavity should be well scraped out with a curette. The incision should be made in the areola alone, or entirely outside of it, because an incision extending from the areola into the encircling skin beyond is apt to be followed by unsightly pigmentation at the circumference of the areola. Ashhurst prefers to make the incision, when possible, in the upper part of the breast; because the compression bandage, subsequently applied, can then better bring the walls of the abscess into apposition, since firm pressure is best obtained by bandaging from below upward. A drainage-tube should be placed in the wound and the incisions sutured. This operation should be done under ether and with the strictest antiseptic precautions. This method of treatment is identical with that for treating abscesses in any other region. It is, indeed, possible that very many abscesses of the breast could be entirely prevented if firm support were given to all breasts after parturition, and if care were taken that no pyogenic germs gained access to the fissures upon the nipple or to the milk ducts. Thorough cleansing after each nursing, and bathing the breast at such times with some non-poisonous, antiseptic lotion would probably efficiently meet the latter requirement. After spontaneous opening of a mammary abscess, the sinuses remaining must be laid open and scraped out under antiseptic precautions. Moderately firm compression with bandages cut to fit the chest, or composed of elastic webbing, and applied over an ordinary gauze dressing, is an efficient adjuvant. It is astonishing to see how a breast freely incised becomes, under such conditions, an efficient organ for nursing after subsequent pregnancies.

Paget's Disease of the Breast.

This affection is a peculiar granular inflammation of the nipple and the areola, which is apt to be followed by malignant disease. If the condition is recognized, the diseased structures should be excised to prevent the occurrence of any further malignant involvement.

Tumors of the Breast.

Pathology and Symptoms.—Tumors of the male breast are rare. The female breast is the seat of all forms of tumor, some of which are more common than others. Carcinomas, sarcomas, and adenomas are the most common growths found in the breast. In not a few cases the tumor is a mixed one, but these mixed tumors usually contain adenoid tissue as one of the elements, and are, therefore, adeno-fibromas, adeno-cystomas, and adeno-sarcomas. It is said that about three-fourths of the tumors found in the breast are carcinomas. The commonest benign growth in this situation is an adeno-fibroma, which is usually called a fibroma or an adenoma. It is, as a rule, however, a mixed tumor, and not a pure fibroma or a pure adenoma.

These adeno-fibromas are very slow in their growth and occur in young women. They are movable, hard, and encapsulated, and are easily enucleated when removal is attempted. The growth is well defined in outline, which is quite different from chronic lobular inflammation, with which it might be confounded. It produces no pulling in of the skin, and no involvement of the lymphatic glands. It is painless, except in persons of a nervous temperament, when neuralgic pain is often present. A tensely filled mammary cyst may very much resemble an adeno-fibroma. The diagnosis is accurately determined by puncturing the obscure tumor with a hypodermic needle, through which fluid will escape if it is a cyst or an adeno-cystoma.

The adeno-cystomas are formed by occlusion and dilatation of the irregularly developed acini and ducts, which occurs in the adenomatous structure. They may consist of one or more large cysts, containing often a great many smaller cysts growing inward from the outer wall of the original tumor. The solidity of the mass depends upon the relative quantity of the brownish fluid and the cyst wall. These tumors do not infiltrate the surrounding tissues, they are encapsulated and do not cause lymphatic involvement; they may, however, develop fungous masses, the surface of which may bleed. Such tumors present to the naked eye the appearance of malignant disease; but such is not their character. After removal they show no tendency to return.

Mammary sarcomas vary very much in their degree of malignancy, and are at times combined with adenoid structures. The round-cell sarcomas, with little intercellular substance, are probably the most malignant of all tumors occurring in the breast. Sarcomas are found, as a rule, in early life; from twenty to thirty-five years being the average age at which this disease is found. Such tumors have a smooth surface, are elastic, mobile, isolated, and rapid in growth, and the cutaneous vessels are often enlarged. The skin finally gives away, and a fungous protrusion occurs; but the lymphatic glands are not involved until the disease has made great progress. Recurrence after removal is very apt to take place about the line of incision. Secondary growths in other parts of the body are very usual in the late stages of the disease.

Carcinomas are frequently found in this region, and are believed sometimes to follow prolonged irritation, such as Paget's disease of the nipple, or chronic lobular inflammation of the gland. Traumatism has been assigned as a cause of carcinomatous disease, and from thirty-five to fifty years is the period of life in which its occurrence is most frequent. Scirrhus or hard carcinoma is a very hard tumor without definite outline.

It is at first movable, but it soon becomes adherent to the skin and to the pectoral muscle; and the gland is thereby finally fastened to the chest wall. The skin over the growth is pulled in, and on account of this retracting influence exerted upon the hair follicles, a characteristic dimpled appearance, often called "pig skin," is produced. If the tumor is directly below the nipple, the nipple is slowly pulled in by the retraction until its appearance is somewhat like that of the navel. This retraction of the nipple occurs only when the tumor is situated directly beneath the nipple: hence its absence does not indicate that the mammary growth is not a carcinoma, unless the tumor is subjacent to the nipple. In some cases of mammary carcinomas there is a slight discharge of fluid from the nipple.

The absence of pain or tenderness in the early stages of the disease often misleads the patient as to its dangerous character, and this error is enforced by the comparatively slow increase in size of the lump found in the breast. In the later stages of the disease, the pain may become great, and seriously so when the axillary glands become the seat of secondary infiltration and produce pressure upon the nerve-trunks in the arm-pit. Instead of scirrhous carcinomas being nodular, they may at times occur as a rapid infiltration of the breast.

Gradually the skin overlying the tumor becomes ulcerated, and from the surface of this foul sore escapes a thin, and often bloody, discharge. Severe hemorrhage may supervene from such an ulcer, but is readily stopped, as a rule, by slight pressure. The carcinomatous ulceration may slowly spread over the whole front of the chest. The lymphatic glands of the axilla are usually quite early involved, though the enlargement may not be perceptible through the skin until they have attained quite a large size.

The cervical glands are not involved until some time after the axillary glands have become the seat of carcinomatous infiltration. Pain and swelling of the arm from pressure upon the nerves, veins, and lymphatics, is one of the late symptoms. Secondary growths occur in the liver, lungs, and bones, and finally death supervenes.

In cases where there is great increase in the fibrous tissue of the tumor, the pathological condition is called atrophic scirrhus. This form of the disease may exist with very little, or no progress, for months or years. This quiescent form of carcinoma is simply one of very slow growth, and its final result differs in no way from that of other cases.

Hard carcinoma is a disease most common in women about forty to fifty years of age. Soft carcinoma, or encephaloid, occurs at an earlier period of life.

Soft carcinomas are much more rapid in their growth, and much more malignant, than hard carcinomas; and appear as round movable tumors, situated deeper in the breast than scirrhus. On examination, such growths feel knobby, but are not exceedingly hard; they are elastic, and at some places feel almost as fluctuating as cystic tumors. The integument overlying them becomes red and œdematous, and suggests the occurrence of suppuration. Ulceration soon supervenes and portions of the tissue become detached, though there is not the same tendency to fungous protrusion as is found in some other tumors. The disease is accompanied with comparatively little pain, but the lymphatic glands and viscera are affected quite early. In the space of eight or ten weeks these growths may assume the size of a cocoanut.

The clinical difference between hard and soft carcinoma resides in the comparative hardness and the chronicity of progress of the former. The

round-cell sarcoma resembles, clinically, the soft carcinoma, but is circumscribed and encapsulated, while the latter is an infiltrated growth. The average duration of soft sarcoma is from six to twelve months, while that of a hard carcinoma is about two and a half years.

Cystic or colloid degenerations may occur in both forms of carcinomas, and occasionally small abscesses may develop in connection with them.

Cystic tumors of the breast are not infrequently found. They may occur during lactation, and then often contain milk. Glandular cysts of various kinds occur in the organ, and contain fluid varying in color from a light straw to a red. These benign tumors are smooth in outline, and do not involve the lymphatic glands, or ulcerate. These are sometimes so hard as to give the surgeon's fingers the impression of a solid growth. At other times they may be distinctly fluctuating. It is at times good policy to puncture the tumor before attempting to remove it by the knife, for I have seen simple cysts excised under the impression that they were carcinomatous nodules. The surgeon must carefully distinguish a benign cyst from a malignant tumor which has undergone cystic degeneration.

Treatment.—Simple cysts are treated by evacuation of the fluid with an aspirator, and then setting up an irritation by scraping the interior of the wall with the point of a needle, or by introducing some counter-irritant, such as the tincture of iodine, or a 5 per cent. solution of carbolic acid. If this does not produce obliteration of the cyst, it may be incised and packed with antiseptic gauze in order to make it granulate from the bottom. If the tumor is a large one, or if there are various cysts, prompt cure will be better obtained by enucleating the cyst from the breast tissue by means of an ordinary straight or elliptical incision through the skin. The breast itself should not be removed unless its structure is practically riddled with hard cysts. Excision of the breast is then justifiable because a return of the enlargement would seem to indicate a malignant tumor, and would, therefore, give great anxiety to the patient.

Clinically, it is frequently impossible to diagnose with certainty sarcoma from carcinoma, or either of these from mixed adenoid growths. It is the surgeon's duty to be guided in treatment more by the clinical symptoms than by the supposed microscopical or histological structure of the tumor.

The hard, lobulated, slow growth, which does not draw in the skin, is probably innocent. An elastic, rapid growth is almost certainly malignant. Experience has taught me that any growths in the breast, which do not, after a few weeks' treatment, show evidence of diminishing in size, had better be removed by operation. If the tumor is a small one, a single incision will enable the operator to enucleate it from the gland tissue without mutilation of the organ. If it is innocent, the patient's mind will be relieved, and the slight operation will be fully justified by the mental relief given to the patient. If these small growths thus early removed prove to be malignant, both the surgeon and the patient are put upon their guard, and warned of the absolute necessity for instant removal of the entire breast and all the axillary glands upon the first signs of recurrence.

Sarcomas may be as malignant, or more malignant, than carcinomas. It is of little interest to the patient to know from which she suffers, hence these two forms of tumor must be treated alike. Pure fibromas are not apt to recur, if all the tumor structure is removed; but this form of tumor is rare. The removal of adeno-fibromas and adeno-cystomas may be advisable, since the difficulty in diagnosing them, before microscopical

examination is made, is great. Pregnancy hastens the development of tumors in the breast; undoubtedly because of the increased blood-supply to the organ.

Excision of the Breast.

When there is the slightest reason to believe that the tumor is a malignant one, it is proper to perform excision of the mammary gland. It is only in benign growths, or in those which are expected to prove themselves benign when subsequent histological study is made, that partial removal of the gland is justifiable. The accepted belief that malignant growths are originally local and not the result of constitutional change is a strong argument in favor of early and radical operation. Operation should not be performed when the disease has become so extensive that it is evidently impossible to remove all the tissue visibly infiltrated; nor in patients who presumably cannot stand the shock of the operation. Under our present methods of operation, however, excision of the breast is almost devoid of danger. I feel, therefore, that it is justifiable to attack these growths under nearly all circumstances, and to follow the first operation by other operations when recurrence takes place, until it is manifestly impossible for the knife to get beyond the limits of infiltration as discernible by the naked eye. It is the tendency to postponement on the part of the patient, and the encouragement which such delay receives at the hands of some physicians, that prevent the best surgical aid being given until the whole gland is involved in the disease. Patients in whom it is evident that the cervical glands are involved, as well as the axillary, and in whom secondary visceral lesions have occurred, are not proper subjects for operation.

In proceeding to attack the growth, the surgeon must recollect that any small portion of the infiltrated tissue left behind is a source of imminent risk, and his incision must, therefore, be made so far beyond the limit of the growth as to avoid, as far as possible, such contingency. It is an imperative rule that the axilla be opened freely and all the lymphatic glands of that region enucleated in every case of malignant tumor of the breast subjected to operation. I have often found the glands high up in the axilla, and those surrounding the axillary vessels involved in the disease, when no evidence of such glandular implication was detected through the skin. I am, therefore, never satisfied until I have laid bare the axillary vein, and carried my finger as far up as the clavicle in the effort at finding these glaudular foci of malignant disease.

The operation of excision of the breast is performed by carrying a circular or elliptical incision around the gland, about three-quarters of an inch from the circumference of the breast, making, what has been called by Gross, a dinner-plate incision. After this extensive incision, the whole gland is dissected from the fascia covering the pectoral muscle, and I prefer always to remove this fascia as well as the breast.

If there is evidence of infiltration of the underlying muscle, the greater and lesser pectorals should be removed, since the stiffness of the arm left after such mutilation is preferable to early return of the disease.

An incision from an inch and a half to two inches long is then carried up into the axilla a little below the edge of the greater pectoral muscle. All the lymphatic glands, and a large portion of the fatty tissue, are then scraped out of the axilla by means of the finger and by the very careful use of the scalpel and forceps. The majority of the glands lie close to

the ribs, and should be looked for in that situation, though every portion of the axillary space and that beneath the clavicle should be thoroughly searched for small glands. It is wise to clear away the tissue around the axillary vein freely first, in order that its location may be clearly appreciated. Laceration of the vein gives rise to copious hemorrhage. It is easily arrested, however, by lateral ligature, by suturing the opening in the vessel with fine catgut, or by grasping the margin of the tear with hemostatic forceps, which should be allowed to remain in the wound for forty-eight hours. The skin covering the posterior portion of the axilla should be perforated for the admission of a rubber drainage-tube, which will permit the exit of wound fluids while the patient lies upon her back. The axillary wound is then closed by sutures, and the raw surface left by the removal of the breast somewhat contracted by strong sutures carried across it. A considerable degree of approximation can be obtained if the skin and subcutaneous tissue are separated from the chest wall by dissecting up the edges a short distance. It is well to place over the open surface a piece of perforated rubber tissue, or Lister protective, before applying the gauze dressing, because the gauze placed directly over the raw surface becomes adherent from the drying of the secretions, and gives pain when the dressing is removed. Skin grafts or skin shavings can be applied to hasten healing after granulation has been established—say at the end of ten days. Grafts of frog skin have been applied by me for this purpose, but without much success.

The first dressing should be changed at the end of twenty-four hours, since there is much oozing from this large, open wound. Subsequent dressings are made when pain, fever, odor, or soiling by the secretions indicate their necessity.

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